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LETTER

FROM

THE SECRETARY OF WAR,

COMMUNICATING

The report of Lieutenant Gustavus C. Doane upon the so-called Yellowstone Expedition of 1870.

MARCH 3, 1871.—Referred to the Committee on Territories and ordered to be printed.

WAR DEPARTMENT, *February* 24, 1871.

The Secretary of War has the honor to submit to the Committee on Territories of the United States Senate the accompanying report of Lieutenant Gustavus C. Doane, United States Army, upon the so-called Yellowstone Expedition of 1870, and to recommend, for the reasons stated by the commander of the Department of Dakota and the General of the Army, that the report be printed for public information.

W. W. BELKNAP,
Secretary of War.

FORT ELLIS, MONTANA TERRITORY,
December 15, 1875.

SIR: The subjoined special order was received from your office by me on the 21st of August, 1870:

[Special Order No. 100.—Extract.]

HEADQUARTERS FORT ELLIS, MONTANA TERRITORY,
August 21, 1870.

II. In accordance with instructions from Headquarters District of Montana, Lieutenant G. C. Doane, Second Cavalry, will proceed with one sergeant and four privates of Company F, Second Cavalry, to escort the surveyor general of Montana to the falls and lakes of the Yellowstone, and return. They will be supplied with thirty days' rations, and one hundred rounds of ammunition per man. The acting assistant quartermaster will furnish them with the necessary transportation.

By order of Major Baker.

J. G. MACADAMS,
First Lieutenant Second Cavalry, Acting Post Adjutant.

In obedience to the above order, I joined the party of General H. D. Washburn, en route for the Yellowstone, and then encamped near Fort Ellis, Montana Territory, with a detachment of Company F, Second Cavalry, consisting of Sergeant William Baker, Privates Charles Moore, John Williamson, William Leipler, and George W. McConnell. The detachment was supplied with two extra saddle horses and five pack mules for the transportation of supplies. A large pavilion tent was

carried for the accommodation of the whole party, in case of stormy weather being encountered; also forty days' rations and an abundant supply of ammunition. The party of civilians from Helena consisted of General H. D. Washburn, surveyor general of Montana, Hon. U. P. Langford, Hon. T. C. Everts, Judge C. Hedges, Samuel T. Hauser, Warren C. Gillette, Benjamin C. Stickney, jr., Walter Trumbull, and Jacob Smith, all of Helena, together with two packers and two cooks. They were furnished with a saddle horse apiece, and nine pack animals for the whole outfit; they were provided with one aneroid barometer and one thermometer, and several pocket compasses, by means of which observations were to be taken at different points on the route.

First day.—We left Fort Ellis on the morning of the 22d, taking the road to the Yellowstone River, in an easterly direction.

Barometer, 25.25; thermometer, 92° noon; elevation, 4,911 feet.

This road follows the general course of the East Gallatin, over a hilly country of limestone formation, with scattering pine timber on the northern slopes. The ravines and small valleys are grown up with quaking aspens and willows. The strata of rock are nearly perpendicular, composed of cliff limestones, interspersed with shales and slate, having nearly a vertical dip to the westward, and greatly broken up by volcanic agencies underneath. Six miles from Fort Ellis we crossed the Yellowstone divide, a ridge of considerable height, forming the apex of two water sheds; one sloping to the Gallatin, the other to the Yellowstone. At the point of crossing the ridge is depressed several hundred feet below its usual altitude, allowing a tolerable wagon road over the pass. The summit affords a fine view of the beautiful Gallatin Valley, with its cordon of snow-capped peaks, its finely timbered water-courses, and its long grassy declivities, dotted with the habitations of pioneers, and blooming with the fruits of industry now ready for harvest.

Barometer, 24.10; thermometer, 70°; elevation, 6,140 feet.

At the head of the East Gallatin ravine a fine seam of coal has been struck in the bed of the stream, where it can be worked to advantage, beneath the carboniferous limestone found in such localities. We traveled thence through a natural pass between high ridges, and down a gentle declivity about three miles, striking the valley of Trail Creek leading to the Yellowstone, and camping on this creek at a point distant about fifteen miles from Fort Ellis. This stream is shut in by high hills, wooded at the summits, and with grassy slopes. Occasionally masses of lava are seen projecting from the highest points. The valley formation is composed of the débris washed down from the hills, together with traces of original drift. Trail Creek at the place of our encampment is a small sized trout stream of great clearness and purity; the general direction of the stream is southeast.

Barometer, 24.30; morning, thermometer, 54°; elevation, 5,803 feet.

Second day.—On the 23d we followed the valley of Trail Creek twelve miles, to within sight of the valley of the Yellowstone. Approaching the river the country became more and more volcanic in appearance, with large masses of basaltic lava cropping out from the high ridges on the right and left. Many of these masses showed a perpendicular front of several hundred feet, with projections resembling towers, castles, and other objects of interest. Several miles away on the right, in the highest range bordering the valley, is Pyramid Mountain, a snow-capped peak, and further to the southward a long range, also covered with snow. On the left of the valley the foot-hills were clothed with beautiful verdure, and the higher summits of the ranges grown up with pine

timber. Crossing a low ridge, in the afternoon, we came in full sight of the Yellowstone Valley and stream. The view from this point was extremely grand, covering a vista of some thirty miles along the river of the valley, which is here several miles wide, and shut in by volcanic mountains of immense height on the opposite side. These peaks are of a dark lava, with ragged summits that stand out in bold relief against the sky. Heavy masses of snow fill the upper ravines, in the summer time feeders of hundreds of springs, which trickle through dense masses of forest on the mountain sides. The valley descends from the foot-hills in gentle declivities, covered with luxuriant grass, and the channels of numerous streams come down from the ranges above on either side. Descending to the valley we followed up the stream, camping at Butler's Ranch, eight miles above. A few antelope were seen during the day, but no other game. Distance traveled twenty miles. In the afternoon we met several Indians belonging to the Crow agency, thirty miles below. In the evening a severe rain storm set in, lasting with intervals throughout the night, and on the following morning the mountains were covered with newly-fallen snow. We remained in camp at Butler's until 12 o'clock on the 24th.

Third day.—Throughout the forenoon it rained occasional showers, but before 12 o'clock the clouds rolled away in heavy masses along the mountain sides, the sun came out, and the atmosphere was clear again. From this point a beautiful view is obtained; the mining camp of Emigrant Gulch is nearly opposite, on a small stream coming down from the mountains, on the opposite side of the river. A few settlements have been made in this immediate vicinity, and small herds of cattle range at will over the broad extent of the valley. Our camp was situated at the base of the foot-hills, near a small grove, from which flowed several large springs of clear water, capable of irrigating the whole bottom in front. The soil here is very fertile, and lies favorably for irrigation; timber is convenient, water everywhere abundant, and the climate for this region remarkably mild. Residents informed me that snow seldom fell in the valley. Stock of every kind subsist through the winter without being fed or sheltered. Excepting the Judith Basin, I have seen no district in the western Territories so eligible for settlement as the upper valley of the Yellowstone. Several of the party were very successful during the morning in fishing for trout, of which we afterward had an abundant and continued supply. The Yellowstone here is from fifty to one hundred yards wide, and at the lowest stage four feet deep on the riffles, running over a bed of drift boulders and gravel, with a very rapid current. The flow of water is fully equal to that of the Missouri at Fort Benton, owing to the rapidity of the current, though the channel is much more narrow.

The Yellowstone trout are peculiar, being the largest variety of the genus caught in waters flowing east. Their numbers are perfectly fabulous, but their appetites extremely dainty. One may fish with the finest tackle of eastern sportsmen, when the water appears to be alive with them, all day long without a bite. Grasshoppers are their peculiar weakness, and using them for bait the most awkward angler can fill a champagne basket in an hour or two. They do not bite with the spiteful greediness of eastern brook trout, but amount to much more in the way of subsistence when caught. Their flesh is of a bright yellow color on the inside of the body, and of a flavor unsurpassed. The barometer stood here 25.10; thermometer, 40°; elevation, 4,837 feet.

We moved in the afternoon at 2.30 p. m., following the course of the valley, crossing several small streams and numerous dry gulches on the

way. After traveling about six miles we crossed, by a difficult pathway, a spur of the mountain, coming down with a bluff bank on the edge of the stream, beyond which the valley opened out to a bottom of large extent and great beauty, back of which the foot-hills rose up in successive plateaus to the summit range. On the opposite side the steep lava mountains came in close to the stream, their lofty fronts covered with stunted timber, and their summits of naked granite piercing the sky. Several small streams ran in from the right, their banks bordered with wild cherry and cottonwood, the branches of the former broken down in many places by grizzly bears in gathering the fruit. A large portion of the bottom land is subject to overflow by the mountain streams, and bears a crop of grass, in many places waist-high. The river is skirted with shrubbery and cedars, the latter having short, thick trunks, too short for ordinary lumber, but yielding most beautiful material for small cabinet work, and of a nature susceptible of an exquisite finish. We followed up this valley about six miles, and camped on the bank of the stream upon a high plateau of drift boulders, and at the opening of an immense cañon, the lower cañon of the Yellowstone. Our mess table was here supplied with antelope, hare, ducks, and grouse killed during the day, with fish caught *ad libitum* in the afternoon. Guards were established here during the night, as there were signs of a party of Indians on the trail ahead of us, all the members of the party taking their tours of this duty, and using in addition the various precautions of lariats, hobbles, &c., not to be neglected while traveling through this country. The night was very clear and somewhat chilly, a strong wind setting in down the cañon toward morning. From observations taken at this point it appears that the maximum variation between high and low-water mark in the Yellowstone is less than eight feet. Distance 12 miles.

Fourth day.—Morning of the 25th, barometer 25.10; thermometer, 40°; elevation, 4,837 feet. Threading our way for a distance of one mile among the enormous granite boulders, we came to the foot of the cañon, through which the trail was very narrow, admitting but one animal at a time, and passing over a high spur of the mountain overlooking the river, which at this point is forced in tremendous rapids, surging through a narrow gorge and over immense boulders in the bed of the stream. The lava walls rise hundreds of feet above this trail, which passes in many places under projecting boulders, holding tenure of their places by a very slight gravitation, and threatening continually a resumption of their journey to the river bed below. Huge masses of trachyte lava, heaped together in every conceivable form, obstruct the narrow way, affording refuge in their interstices to numbers of rattlesnakes, which made hostile demonstrations on being disturbed, and remained masters of the situation after we had passed. After scrambling over rocks for a distance of two miles, we came to where the valley opens again slightly, and the trail leaving the river passes to the summit of a ridge on the right, where we found at an elevation 1,000 feet above the river a small but beautiful lake. On descending presently from the mountain we again entered the river valley, which was here from one and a half to two miles wide. The rock formation, after passing the narrow gorge, was of limestone strata, with superincumbent sandstones and shales; small deposits of gypsum appeared, and over all drift boulders were scattered, even on the summits of the higher hills; behind these granite peaks rose up, worn at their bases by the drift currents. The soil here lost its fertility, the level lands being covered with a heavy growth of sage brush, and the few streams of water impregnated with alkali. The

general trend of the river is to the southeast. About noon we passed a very singular formation on the right; the strata of limestone turned up edgewise formed a hill several hundred feet in height, on the face of which the softer portions of the strata having been washed away caused the more solid limestones to stand out from the hillside in two immense walls, the crests of which were covered with stunted pine trees. Near these a dark stratum of coal was visible, also a red stratum, reported to be cinnabar, which we did not, however, examine. From this point to the mouth of Gardiner's River, a distance of twelve miles, the valley was full of original drift. The boulders were of Quincy granite, and, wherever found, were worn off smooth as if by the action of water. The ground rose rapidly as we proceeded, passing from a dead level alkali plain to a succession of plateaus, covered slightly with a sterile soil, through which the limestones cropped out constantly. In many places deep ravines were worn down in the strata by the waters from the melting snows; numerous springs were seen far up on the mountain sides, but their waters sank among the arid foot-hills without reaching the river. This desert region, inclosed by mountains covered with verdure, and on the banks of a large stream, is one of the anomalies common in the West, where the presence of limestones or sandstones, in horizontal strata especially, almost always means want of water, and consequent desolation. We camped at the mouth of Gardiner's River, a large stream coming in through a deep and gloomy cañon from the south. This was our first poor camping place, grass being very scarce, and the slopes of the range covered entirely with sage brush. From this camp was seen the smoke of fires on the mountains in front, while Indian signs became more numerous and distinct. Many prospect holes of miners were passed during the day, and several abandoned camps of the previous year. The river at this point shrinks to half its usual size, lost among the boulders of the drift, immense masses of which choke up the stream in many places, forming alternate pools and rapids, which afforded great delight to the fishermen of our party. Some of the huge masses of granite in the bed of the stream are hollowed out by the action of the water into many singular forms. We here found numerous specimens of petrified wood, but no traces of fossils, except in the solid limestone of the higher ledges. Two or three miles above, and on the opposite side of the Yellowstone from this point, is the mouth of Bear Gulch, an almost inaccessible mining district, not being worked at present, but said to yield well during the season of operations. Distance 18 miles.

Morning—Barometer, 24.80; thermometer, 49°; elevation, 5,215 feet. Noon—Barometer, 23.10; thermometer, 72°; elevation, 7,331 feet.

Fifth day—August 26.—We left camp at 11 o'clock a. m., and crossed Gardiner's River, which at this point is a mountain torrent about twenty yards wide and three feet in depth. We kept the Yellowstone to our left, and finding the cañon impassable passed over several high spurs coming down from the mountains, over which the way was much obstructed by falling timber, and reached, at an elevation of 7,331 feet, an immense rolling plateau extending as far as the eye could reach. This elevated scope of country is about thirty miles in extent, with a general declivity to the northward. Its surface is an undulated prairie dotted with groves of pine and aspen. Numerous lakes are scattered throughout its whole extent, and great numbers of springs, which flow down the slopes and are lost in the volume of the Yellowstone. The river breaks through this plateau in a winding and impassable cañon of trachyte lava over 2,000 feet in depth; the middle cañon of the Yellowstone,

rolling over volcanic boulders in some places, and in others forming still pools of seemingly fathomless depth. At one point it dashes here and there, lashed to a white foam, upon its rocky bed; at another it subsides into a crystal mirror wherever a deep basin occurs in the channel. Numerous small cascades are seen tumbling from the rocky walls at different points, and the river appears from the lofty summits a mere ribbon of foam in the immeasurable distance below. This huge abyss, through walls of flinty lava, has not been worn away by the waters, for no trace of fluvial agency is left upon the rocks; it is a cleft in the strata brought about by volcanic action, plainly shown by that irregular structure which gives such a ragged appearance to all such igneous formations. Standing on the brink of the chasm the heavy roaring of the imprisoned river comes to the ear only in a sort of hollow, hungry growl, scarcely audible from the depths, and strongly suggestive of demons in torment below. Lofty pines on the bank of the stream "dwindle to shrubs in dizziness of distance." Everything beneath has a weird and deceptive appearance. The water does not look like water, but like oil. Numerous fish-hawks are seen busily plying their vocation, sailing high above the waters, and yet a thousand feet below the spectator. In the clefts of the rocks down, hundreds of feet down, bald eagles have their eyries, from which we can see them swooping still further into the depths to rob the ospreys of their hard-earned trout. It is grand, gloomy, and terrible; a solitude peopled with fantastic ideas; an empire of shadows and of turmoil. The great plateau had been recently burned off to drive away the game, and the woods were still on fire in every direction. In the morning I had ridden foward on the trail hoping to find a passage through the cañon, and after having endeavored to descend its precipitous banks in several places without success, I had climbed to the summit of the plateau and followed the trail of two hunters who had camped with us on the previous night and were gone in advance after game. Mr. Everts and Private Williamson accompanied me; the latter killed an antelope on the trail immediately after reaching the summit, which we left as an indication to the party following. Our course led along the great plateau, about three miles to the right of the cañon, toward which the ground fell off with a slight declivity. Passing over the high rolling prairie for several miles, we struck at length a heavy Indian trail leading up the river, and finding a small colt abandoned on the range, we knew they were but a short distance ahead of us. The plateau formation is of lava, in horizontal layers, as it cooled in a surface flow; these have been upheaved in places by a subterraneous action into wave-like undulations, and occasionally granite shafts protrude through the strata, forming landmarks at once permanent, and generally of picturesque form. They resemble dark icebergs stranded in an ocean of green; rising high above the tops of the trees, in wooded districts, or standing out grim and solid on the grassy expanse of the prairie land. On the lower verge of this plateau we bade farewell to drift, its altitude being far above the line of operations of the ice period. I noticed that the grass in many places was here too green to burn, though already parched in the lower valleys we had already traversed, and that many flowers were just in bloom. It was still early summer in this elevated region, far above the perpetual snow line of the mountains on the Gallatin.

In the afternoon the trail led us through a deep cañon to the south, which opened out on a small valley at the confluence of the East Fork of the Yellowstone. The main stream here turns to the southwest, the branch coming in through a deep rocky valley in a course due east.

The opening formed at the junction of the two streams is probably three miles in diameter, and of nearly circular shape. The mountains on the opposite side and toward the head of the East Fork are composed wholly of lava, heaped up in every imaginable form. In the center of the valley rises a table mountain, perpendicular on its sides, and capped with a horizontal stratum of trap rock about fifty feet in depth; standing isolated in the surrounding level valley, and between the channels of the two streams, it has a very singular and remarkable appearance. The channel of the Yellowstone, where it enters this valley, cuts to the depth of 300 feet, through a bed of gypsum, overlaid by a stratum of trap, the columns of which show great perfection of crystallization. The valley itself abounds in springs, small lakes, and marshes. The slopes and ravines to the right and beyond the Yellowstone are heavily timbered with pine, affording a strong contrast to the bare rocks on the opposite side of East Fork.

Descending from the plateau through a steep ravine into the valley, and skirting for a distance of two miles a swampy flat, we came to the first warm spring found on the route. This spring is on the right of the trail, and of small size; temperature, milk-warm, and highly impregnated with sulphur. Passing thence, the trail leads over a spur of the mountain coming in from the right, and through a deep ravine, crossing Warm Spring Creek, where we camped for the night, in company with the two hunters aforementioned. The remainder of the party did not arrive until the next day. We passed, a mile before going into camp, near a small lake, the "wickey ups" of fifteen lodges of Crows, the Indians whose trails we had been following across the plateau. Distance traveled 18 miles.

Sixth day—August 27.—Barometer, 23.70; thermometer, morning, 46°; elevation, 6,546 feet. We remained in camp at Hot Spring Creek awaiting the arrival of the rest of the party. In the morning I rode down to the confluence of the two rivers and found the East Fork to be a smaller stream than Gardiner's River. This valley showed evidence of diminished volcanic action, calcareous mounds being frequently seen, which had originated in the action of hot springs, the waters of which had now ceased to flow. The valley was full of drift, and numerous prospect holes indicated the enterprise of the miners in penetrating these unknown regions thus far. At the mouth of Hot Spring Creek we found a system of sulphurous and mineral springs distributed for a distance of two miles in the bottom of the deep cañon through which the river runs. These springs were invariably small, several of them having the temperature at the boiling point; many of them were highly sulphurous, having in fact more sulphur than they could carry in solution, and depositing it in yellowish beds along their courses. Several of them were impregnated with iron, alum, and other substances. The sulphurous fumes could be detected at the distance of half a mile. The gypsum walls of the cañon were very remarkable, the excess of sulphur in the combination over the proportion of limestone giving a brilliant yellow color to the rocks in many places. The formation was usually very friable, falling with a natural slope to the edge of the stream, but occasionally masses of a more solid nature projected from the wall in curious shapes of towers, minarets, &c., while above and over all the solid ledge of trap, with its dark and well-defined columns, made a rich and beautiful border inclosing the pictured rocks below.

Standing on the margin of the stream, a few hundred yards further down, is Column Rock, a huge pile of alternate layers of basalt and amygdaloid cement, several hundred feet in height, surmounted by a

pinnacle of trap, the columns of which are exactly perpendicular, and of a perfect outline. The great curiosity of the locality, however, is the Tower Fall of Hot Spring Creek, where that stream is precipitated, in one unbroken body, from an amygdaloid ledge, a sheer descent of 115 feet, into a deep gorge, joining the Yellowstone a few hundred yards below. At the crest of the fall the stream has cut its way through amygdaloid masses, leaving tall spires of rock from 50 to 100 feet in height, and worn in every conceivable shape. These are very friable, crumbling under slight pressure; several of them stand like sentinels on the very brink of the fall. A view from the summit of one of these spires is exceedingly beautiful; the clear icy stream plunges from a brink 100 feet beneath to the bottom of the chasm, over 200 feet below, and thence rushes through the narrow gorge, tumbling over boulders and tree trunks fallen in the channel. The sides of the chasm are worn away into caverns lined with variously-tinted mosses, nourished by clouds of spray which rise from the cataract; while above, and to the left, a spur from the great plateau rises above all, with a perpendicular front of 400 feet. The fall is accessible either at the brink or foot, and fine views can be obtained from either side of the cañon. In appearance, they strongly resemble those of the Minnehaha, but are several times as high, and run at least eight times the volume of water. In the basin we found a large petrified log imbedded in the débris. Nothing can be more chastely beautiful than this lovely cascade, hidden away in the dim light of overshadowing rocks and woods, its very voice hushed to a low murmur, unheard at the distance of a few hundred yards. Thousands might pass by within a half mile and not dream of its existence; but once seen, it passes to the list of most pleasant memories. In the afternoon the remainder of the party arrived, having lost the trail on the previous day.

Seventh day—August 28.—We remained in camp, visiting the different localities of interest in the neighborhood. The Indians we had been following crossed the river a short distance above the mouth of Hot Spring Creek, on what is known as the Bannack Trail, leading from the headwaters of the Snake River, around by the way of the headwaters of the Madison and Gallatin Rivers, and through this district to the great buffalo range between here and the Missouri. The two hunters previously spoken of followed this trail across the range to the head of Rose Bud Creek. They found on the headwaters of the East Fork the skeletons of two hunters murdered by the Indians two years ago. They also report the existence of numerous hot springs, geysers, jets of steam issuing from the rocks, and other curiosities, at different points about the sources of that stream. They report the country beyond the range, at the distance of 70 miles, to fall off to a rolling prairie, black with buffalo as far as the eye can reach. They found strong indications of gold on the head of Rose Bud, but were deterred from prospecting for fear of the Sioux.

Since leaving Fort Ellis I had suffered considerably with a pain in the thumb of my right hand, which was now increased to such an extent as to amount to absolute torture. I had it lanced here three times to the bone with a very dull pocket-knife, in the hope of relief, which, however, did not come. It proved a felon of the most malignant class, and was destined to subject me to infernal agonies. I passed the night walking in front of the camp-fire, with a wet bandage around my arm to keep down the pain.

Eighth day—August 29.—We broke camp about 8 o'clock and for a distance of six miles climbed the divide separating Warm Spring Creek

from the Yellowstone, skirting along the cañon of the former stream. The ground for that distance rises very rapidly, and is much broken by creek beds running parallel with the river. Following the highest ridges we presently come to a point from whence could be overlooked the Grand Cañon, cleaving the slopes and breaking through the lofty mountain ranges directly in front. Its perpendicular sides, wherever visible, of the yellow sulphuric tint above described, and its crest on either side of the river, mantled with heavy timber, extending beyond in an unbroken forest as far as the eye could reach. This, the upper cañon of the Yellowstone, is about twenty miles in length, reaching to the foot of the Great Falls, is impassable throughout its whole extent, and only accessible to the water's edge at a few points and by dint of severe labor. Through the mountain gap formed by the cañon, and on the interior slopes some twenty miles distant, an object now appeared, which drew a simultaneous expression of wonder from every one in the party. A column of steam, rising from the dense woods to the height of several hundred feet, became distinctly visible. We had all heard fabulous stories of this region, and were somewhat skeptical of appearances. At first it was pronounced a fire in the woods, but presently some one noticed that the vapor rose in regular puffs, as if expelled with a great force. Then conviction was forced upon us. It was, indeed, a great column of steam, puffing away on the lofty mountain side, escaping with a roaring sound audible at a long distance, even through the heavy forest. A hearty cheer rang out at this discovery, and we pressed onward with renewed enthusiasm. Following the ridge leading to the peak nearest the cañon, and the highest of the range, we were soon at its base; then making a detour to the right, crossing several ugly ravines and through a gap in the ridge, we passed over the Elephant's Back and entered the great basin of the Yellowstone Lake. Observations were taken from the summit of the peak, which we named Mount Washburn. Noon, barometer, 20.80; thermometer, 50°; elevation, 9,966 feet.

The view from the summit is beyond all adequate description. Looking northward from the base of the mountain the great plateau stretches away to the front and left with its innumerable groves and sparkling waters, a variegated landscape of surpassing beauty, bounded on its extreme verge by the cañons of the Yellowstone. The pure atmosphere of this lofty region causes every outline of tree, rock, or lakelet to be visible with wonderful distinctness, and objects twenty miles away appear as if very near at hand. Still further to the left the snowy ranges on the headwaters of Gardiner's River stretch away to the westward, joining those on the head of the Gallatin, and forming, with the Elephant's Back, a continuous chain, bending constantly to the south, the rim of the Yellowstone Basin. On the verge of the horizon appear, like mole hills in the distance, and far below, the white summits above the Gallatin Valley. These never thaw during the summer months, though several thousand feet lower than where we now stand upon the bare granite and no snow visible near, save in the depths of shaded ravines. Beyond the plateau to the right front is the deep valley of the East Fork bearing away eastward, and still beyond, ragged volcanic peaks, heaped in inextricable confusion, as far as the limit of vision extends. On the east, close beneath our feet, yawns the immense gulf of the Grand Cañon, cutting away the bases of two mountains in forcing a passage through the range. Its yellow walls divide the landscape nearly in a straight line to the junction of Warm Spring Creek below. The ragged edges of the chasm are from two hundred to five hundred yards apart, its depth so profound that the river bed is no where visible. No sound

reaches the ear from the bottom of the abyss; the sun's rays are reflected on the further wall and then lost in the darkness below. The mind struggles and then falls back upon itself despairing in the effort to grasp by a single thought the idea of its immensity. Beyond, a gentle declivity, sloping from the summit of the broken range, extends to the limit of vision, a wilderness of unbroken pine forest.

Turning southward, a new and strange scene bursts upon the view. Filling the whole field of vision, and with its boundaries in the verge of the horizon, lies the great volcanic basin of the Yellowstone. Nearly circular in form, from fifty to seventy-five miles in diameter, and with a general depression of about 2,000 feet below the summits of the great ranges which forms its outer rim, Mount Washburn lies in the point of the circumference, northeast from the center of the basin. Far away in the southwest, the three great Tetons on Snake River fill another space in the circle, and connecting these two highest are cresent ranges, one westward and south, past the Gardiner's River and Gallatin, bounding the lower Madison and thence to the Jefferson, and by the Snake River range to the Tetons. Another eastward and south, a continuous range by the head of Rose Bud, inclosing the sources of the Snake, and joining the Tetons beyond. Between the south and west points, this vast circle is broken through in many places for the passage of the rivers; but a single glance at the interior slopes of the ranges shows that a former complete connection existed, and that the great basin has been formerly one vast crater of a now extinct volcano. The nature of the rocks, the steepness and outline of the interior walls, together with other peculiarities to be mentioned hereafter, render this conclusion a certainty. The lowest point in this great amphitheater lay directly in front of us, and about eight miles distant. A grassy valley, branching between low ridges, running from the river toward the center of the basin. A small stream rose in this valley, breaking through the ridges to the west in a deep cañon, and falling into the channel of the Yellowstone, which here bears in a northeast course, flowing in view as far as the confluence of the small stream, thence plunged into the Grand Cañon, and hidden from sight. No falls can be seen, but their location is readily detected by the sudden disappearance of the river; beyond this open valley the basin appears to be filled with a succession of low, converging ridges, heavily timbered, and all of about an equal altitude.

To the south appears a broad sheet of water—the Yellowstone Lake. Across the Grand Cañon, on the slope of the great mountain wall, is the steam jet seen this morning; and in the next ravine beyond it, are six more of inferior volume. Still further south are others, to the number of perhaps twenty, and to the southwest more of them, scattered over the vast expanse of the basin, rising from behind the wooded hills in every direction. The view in this respect strongly resembles that from the Alleghanies, where they overlook iron and coal districts, with all their furnaces in active operation, save that one looks in vain here for the thifty towns, country villas, steamboats, and railroad depots.

The surface formation of Mount Washburn on the northern or outside slope is a spongy lava. The body of the peak is of feldspathic granite. Its southward, or inward slope, is very precipitous, with evidence of once having been much more so; at present, however, having a talus of material broken away by the elements. Scattered over the outside slopes we found beautiful specimens of sardonyx, identical with those found on the Sierra Nevada. Descending the mountain side a couple of miles, we camped on the head of a small stream, flowing west into the Grand Cañon. Distance traveled, 12 miles.

Barometer, 23.00; thermometer, 50°; elevation, 7,270 feet.

Coming into camp in advance, passing through a grove of pine on the margin of a little creek, I was met face to face on the path by two magnificent buck elk, one of which I wounded, but lost in the woods. Shortly afterward Mr. Smith started up a small bear, which also got away. The ground was everywhere tracked by the passage of herds of elk and mountain sheep; and bear sign was everywhere visible. In the evening, accompanied by Mr. Washburn and Mr. Hedges, I followed down the channel of the creek to the brink of the Grand Cañon. Passing for a mile down an open glade with a heavy coating of rank, green grass, and dotted with clumps of pine, we came to a bed of whitish substance extending for a hundred yards on each side of the creek and through which its channel ran. Having no chemical tests we were at a loss to classify this deposit; some thought it volcanic ashes. This formation abounds in the vicinity in deep beds underlying the ridges of the valley and overlaid by masses of lava almost entirely composed of obsidian. A mile below this point, small, hot springs of sulphur, sulphate of copper, alum, and mud, were found in great numbers; and soon we came to an opening in the woods, at the foot of a bluff, where there appeared a system of boiling-hot springs of muddy water, with clouds of vapor escaping therefrom. The large ones were five in number, of which the first measured 25 by 30 feet, hot, with slight ebullition in the center; water slate color, and not flowing. The second, 4 feet in diameter, boiling violently and flowing; water dark brown, muddy, but without deposit. The third, 20 by 25 feet measurement, brown, muddy water, boiling up three feet in the center, with an occasional violent rush of vapor to the height of 100 feet. This spring flows periodically. It lies close under a projecting bank of sulphureted calcareous formation; and in one corner of the spring rises a sort of honey-comb deposit, of beautifully-variegated colorings, and composed of sublimated sulphur on a bed of metallic luster resembling silver. This deposit is several feet in height, and would weigh many tons. The vapor is forced through the interstices of this honey-comb with a loud, hissing sound. Above this spring, 30 feet on the bank, is a fourth, similar, and measuring 7 by 8 feet; and beyond, another, of black, paint-like consistency, which deposits a crater from the ejected material. Around these larger are dozens of smaller springs, vapor jets, and mud spouts. The ground in the vicinity is in layers, like pie-crust, which break through or settle when trodden upon, giving one a sensation of extreme uncertainty, as a rush of hot, sulphur vapor invariably rises from the fracture. It was with extreme difficulty and some little risk that we obtained specimens of the deposits.

Continuing on our way three miles farther we came to a dense growth of small timber on the brink of the Grand Cañon, and were stopped by its sheer wall, which fell off 1,500 feet to a bench, grown up with pines, through which ran an apparently narrow chasm so deep that the waters could not be seen nor heard. It was a second edition of the bottomless pit. The small stream had hollowed out a channel through the lower bench several hundred feet in depth, additional; but even looking down through this fissure did not enable us to see the Yellowstone. After resting on the brink, and gazing long with wonder into the fearful gulf below, we returned to camp, having had a walk of ten miles, profoundly impressed with the laborious nature of our undertaking and more than satisfied with the opening up of the campaign.

Ninth day—August 30.—We moved at 9 a. m., in a southerly course, with a detour to the right to avoid a marshy ravine, and in three miles struck the head of the low valley seen from Mount Washburn yester-

day. Following its windings for several miles, we came to the lowest point, where the stream above referred to enters the cañon, and here camped. Distance traveled eight miles. This valley is from one-half to three miles wide, with branches in every direction among the wooded ridges, is clothed with a heavy mantle of excellent grass, abounds in springs of pure water, and was formerly the bottom of a lake. The profile of the creek bank showed the following: Bed of the stream dark lava, surface flow; above, obsidian and grantite pebbles, six feet; then quartzose sandstone two feet, limestone one foot, and volcanic ashes one to four feet; thus showing several estuary deposits above the volcanic rocks. In company with others of the party, I rode down the creek, following the brink of its cañon, which gradually deepens to 300 feet, as far as its junction with the Yellowstone. As we approached the Grand Cañon a dull roaring sound warned us that the falls were near at hand. I had been suffering greatly during the forenoon, being obliged to gallop from one spring to another to keep wet the wrappings of my hand. Following this cañon kept me away from water so long that the pain became utterly unsupportable. I abandoned my horse, and have no distinct recollection of how I got to the water's edge, but presently found myself with my arm up to the elbow in the Yellowstone a few yards below the foot of a graceful cascade. In a few minutes, the pain becoming allayed, I proceeded to explore the locality. I had descended the cañon at a point where the creek joined the river, precipitated into a gorge just above its juncture in a lovely cascade of three falls, in the aggregate 100 feet in height. This was named Crystal Cascade, and the stream Cascade Creek. In the bed of the gorge were to be found an infinite variety of volcanic specimens, quartz, feldspar, mica, granites, lavas, basalts, composite crystals; in fact, everything, from asbestos to obsidian, was represented by fragments in the bed of this stream. There were also beautiful clay stone specimens, of which we afterward learned the origin.

At the foot of the gorge and on the margin of the Yellowstone stood a high promontory of concretionary lava, literally filled with volcanic butternuts. Many of these were loose, and could be taken out of the rock with the hand; broken open they were invariably hollow, and lined with minute quartz crystals of various tints. This formation is rare, but occurs frequently in the great basin. From the outer point of this promontory can be seen the foot of the upper fall of the Yellowstone, and I climbed to the summit to obtain a view.

After ascending about 600 feet a plateau is reached overlooking the cataract, which is inaccessible at its brink without the use of ropes. The river comes down for over half a mile above over a series of lava ledges, each terminating in a fall of from 10 to 15 feet; of these there are five. Then with a tremendous current, and confined in a rocky channel, narrowed to a space of 80 feet, it is hurled from the brink of a perpendicular wall, a sheer descent of 115 feet. So rapid is the current that the great mass of foam shoots out clear of the rock and falls far out in its basin, striking upon a covered ledge at an angle which causes a portion of the water to be projected like a broad fan into the air, with a hissing sound to the distance of 60 feet, and afterward dissolving into clouds of spray. The depth of water on the brink is about 4 feet, and the concussion of the fall is tremendous. A lava promontory overhangs the basin on either side, giving fine opportunities for observation. After watching the rushing waters for an hour, other members of the party arrived, with whom I returned to camp.

Barometer, 22.60; thermometer, 46°; elevation, 7,697 feet.

Tenth day—August 31.—The day was spent without moving camp, examining the falls and cañon. Returning in the morning to the upper fall we measured its height, given above, and followed down the cañon. The brink of the lower fall is visible from the ledges of the upper; distance between the falls, a little over half a mile. The cañon between the falls is lava, alternating with the sulphur formation; is 450 deep, and about 200 yards across. The stream flows over lava, granite, and boulders. The lower fall at its brink is 90 feet across, and without rapids above, though the current is very swift. It is precipitated clear of the rock a perpendicular descent of 350 feet, the cañon at its foot being 800 feet in depth. A promontory of the wall rises 120 feet above the brink, and overhanging the basin, from which the view is inconceivably grand; the heavy body of water dissolving into a sheet of foam, pours into an immense circular caldron, overhung by the gigantic walls. From the depths of the abyss comes up a humming sound, very different from the wild roaring of the upper cataract. From a projecting promontory a mile below, the finest view is obtained. Both of these cataracts deserve to be ranked among the great waterfalls of the continent. No adequate standard of comparison between such objects, either in beauty or grandeur, can well be obtained. Every great cascade has a language and an idea peculiarly its own, embodied, as it were, in the flow of its waters. Thus the impression on the mind conveyed by Niagara may be summed up as "Overwhelming power;" of the Yosemite, as "Altitude;" of the Shoshone Fall, in the midst of a desert, as "Going to waste." So the upper fall of the Yellowstone may be said to embody the idea of "Momentum," and the lower fall of "Gravitation." In scenic beauty, the upper cataract far excels the lower. It has life, animation, while the lower one simply follows its channel; both, however, are eclipsed, as it were, by the singular wonders of the mighty cañon below. This deepens rapidly; the stream flowing over rapids continually. The ground on the brink rises also to the foot of Mount Washburn, the falls being at a low point in the basin; therefore the cañon walls increase in altitude in following down the stream. Several of the party descended into the chasm a short distance below the fall, but could not reach its foot. A mile below several steam jets play across, a few feet above the water. The walls of the cañon are of gypsum, in some places having an incrustation of lime white as snow, from which the reflected rays of the sun produce a dazzling effect, rendering it painful to look into the gulf. In others the rock is crystalline and almost wholly sulphur, of a dark yellow color, with streaks of red, green, and black, caused by the percolations of hot mineral waters, of which thousands of springs are seen, in many instances, flowing from spouts high up on the walls on either side. The combinations of metallic lusters in the coloring of the walls is truly wonderful, surpassing, doubtless, anything of the kind on the face of the globe. The ground slopes *to* the cañon on the opposite or east side, and *from* it to the low valley on the west. Three miles below the fall the chasm is 1,050 feet deep. In some places masses of the rock have crumbled and slid down in a talus of loose material at the foot; in others, promontories stand out in all manner of fantastic forms, affording vistas of wonder utterly beyond the power of description. On the caps of these dizzy heights, mountain sheep and elk rest during the night. I followed down the stream to where it breaks through the range, on horseback, threading my way through the forest on game trails, with little difficulty. Selecting the channel of a small creek, and leaving the horses, I followed it down on foot, wading in the bed of the stream, which fell off at an angle of

about 30°, between walls of the gypsum. Private McConnell accompanied me. On entering the ravine we came at once to hot springs of sulphur, sulphate of copper, alum, steam jets, &c., in endless variety, some of them of very peculiar form. One of them in particular, of sulphur, had built up a tall spire from the slope of the wall, standing out like an enormous horn, with hot water trickling down its sides. The creek ran on a bed of solid rock, in many places smooth and slippery, in others obstructed by masses of débris formed from the overhanging cliffs of the sulphureted limestone above. After descending for three miles in the channel we came to a sort of bench or terrace, the same one seen previously in following down the creek from our first camp in the basin. Here we found a large flock of mountain sheep, very tame, and greatly astonished, no doubt, at our sudden appearance. McConnell killed one and wounded another, whereupon the rest disappeared, clambering up the steep walls with a celerity truly astonishing. We were now 1,500 feet below the brink. From here the creek channel was more precipitous, and for a mile we climbed downward over masses of rock and fallen trees, splashing in warm water, ducking under cascades, and skirting close against sideling places to keep from falling into boiling caldrons in the channel. After four hours of hard labor since leaving the horses, we finally reached the bottom of the gulf and the margin of the Yellowstone, famished with thirst, wet and exhausted. The river water here is quite warm and of a villainously alum and sulphurous taste. Its margin is lined with all kinds of chemical springs, some depositing craters of calcareous rock, others muddy, black, blue, slaty, or reddish water. The internal heat renders the atmosphere oppressive, though a strong breeze draws through the cañon. A frying sound comes constantly to the ear, mingled with the rush of the current. The place abounds with sickening and purgatorial smells. We had come down the ravine at least four miles, and looking upward the fearful wall appeared to reach the sky. It was about 3 o'clock p. m., and stars could be distinctly seen, so much of the sunlight was cut off from entering the chasm. Tall pines on the extreme verge appeared the height of two or three feet. The cañon, as before said, was in two benches, with a plateau on either side, about half way down. This plateau, about a hundred yards in width, looked from below like a mere shelf against the wall; the total depth was not less than 2,500 feet, and more probably 3,000. There are perhaps other cañons longer and deeper than this one, but surely none combining grandeur and immensity with peculiarity of formation and profusion of volcanic or chemical phenomena.

Returning to the summit, we were five hours reaching our horses, by which time darkness had set in, and we were without a trail, in the dense forest, having fallen timber to evade and treacherous marshes to cross on our way to camp. I knew the general direction, however, and took a straight course, using great caution in threading the marshes, wherein our horses sank in up to their bodies nevertheless. Fortune favored us, and we arrived in camp at 11 o'clock at night, wet and chilled to the bone. To me it was terribly fatiguing after the excitement had passed away, as I was becoming very weak from continued loss of rest or sleep.

Eleventh day—September 1.—We moved out at 10 a. m., heading the Cascade Ravine through open timber, and following the summit of one of the low ridges to the river; striking a game trail along its bank at a point two miles above the upper fall. The stream here changes its character altogether, running in the center of an open glade, bank full,

with grassy margins, a slow current, and spread out to a width of from 200 to 400 feet. The bottom is pebbly or quicksand, the water of crystal clearness, and cold again. The little valley is marshy, for which reason we traveled on the slopes of the ridges, crossing at intervals open glades between them. Through one of these flows Alum Creek, a small stream coming in from the west, its bed dyed of an inky blackness by the deposit from its strongly impregnated waters. Six miles above the falls we entered a wide valley of calcareous formation, open and branching among timber ridges on either side of the river, which runs through its center in a northeast course, an old lake bed, as are all the grassy sections of the basin. On the north side of the river appeared the great steam jets before alluded to, in ravines opening into this valley. A good-sized stream, known as Hellroaring River, emptied in near by from the north. From the southwest a shallow stream came in also, and in front, near the center of the valley, were several large white hills to which we directed our course. Elk were feeding in small bands on the other side of the valley, and large flocks of water fowl were frequently seen sporting in the river channel. The white hills, or the "Seven Hills," as we afterward named them, proved well worth a visit. Here is a group of large mounds varying from 200 to 500 feet in height, each of which has been deposited by the action of a single spring, and at their basis a system of nature's chemical works on the grandest scale. I climbed to the summit of the two loftiest of these hills; their formations are identical, all being composed of calcareous matter, solid within, but shelly on the exterior, and when decomposed of a snowy whiteness. The slopes were covered with shales, slid down from above. On the summits were ruins of craters of great size and former solidity, now choked up with débris. From hydrostatic pressure all the springs had burst out below at the foot of the slopes, but through innumerable small vents all over the surface of the hills hot sulphur vapor escaped, subliming around the vents in splendid crystals of large size. The rocks were everywhere warm, and in some places hot to the touch; wherever the horses feet broke through the crust hot vapor escaped. Everywhere the rocks gave forth a hollow sound beneath our tread, and in many places the intense heat caused them to bulge out in a scaly formation, which broke through on the slightest pressure of the foot, whereupon scalding vapor poured out in such volumes as to cause a hasty retreat. The greatest spring in appearance lies at the base of the highest hill and is intensely sulphurous, great clouds of vapor constantly escaping. It measures 15 by 20 feet on the inside; the water boils up constantly from three to seven feet in height, the whole surface rising and falling occasionally with a flux and reflux of four feet additional, overflowing its basin and receding every few minutes. The basin is built up with a solid rim or lining of pure crystalline sulphur, four feet in width all around the edge, probably amounting to forty tons in weight. The water is clear, but of a whitish cast, and above the boiling point, steam being evolved from its surface. The basin cannot be approached nearer than 20 feet distant on account of the scalding vapors. A small channel leads down the slope and for several hundred feet its bed is incrusted with a sulphur deposit, showing that the spring occasionally flows a considerable quantity of water. This deposit is from three to ten inches deep. Farther along the base of the same hill is a sulphurous cavern 20 feet in visible depth and 8 feet in diameter, out of which issued jets of vapor with a sound like the puffing of a high-pressure steamboat. These jets pulsate regularly, and the vapor is intensely hot. Scattered along the bases of the next hills

near by were great numbers of small sulphur springs of the same character and deposits of the larger one, any one of which would be counted a great curiosity in any district but this. About one hundred yards below is a spring of slate-colored water, 70 by 30 feet, an immense caldron, boiling constantly. Still farther on is a basin of perhaps four acres, containing from twenty to thirty mud springs, varying from 2 to 20 feet in diameter, and of depths below the surface from three to eight feet. The mud ejected is of different degrees of consistency, but generally about the thickness of common mortar, and mostly of an iron brown color. It boils slowly, like mush, with bubbles of gas escaping, and is spouted to various heights from 2 to 40 feet, falling with dull splashes around the edges of the craters, which are being built up continually and continually caving in, to be worked over and ejected as before. Some of the springs throw up yellow mud, others white, and a few pink. The different springs of all classes had no apparent connection with each other, though often but a few feet apart; the mud being of different colors, the basins having different levels, and the pulsations being independent; one being frequently in violent ebullition, while another near by was quiescent. A plasterer would go into ecstasies over this mortar, which is worked to such a degree of fineness that it can be dried in large lumps, either in the sun or in a fire, without a sign of cracking, and when once dry is a soft, finely grained stone, resembling clay slate when dark, or meerschaum when white. Mortar might well be good after being constantly worked for perhaps ten thousand years.

In a ravine near by was a large flowing spring of alum water, and several of sulphate of copper. Springs of this latter class are always clear and deep, with beautiful basins, raised slighly at the rim, and lined with incrustations of brilliant colors. Scattered over the whole area of one-fourth of a mile in diameter, in addition to the above, were hundreds of small spouts of vapor, water, and mud. In a basin by itself was a black mud spring, 20 by 40 feet, throwing mortar a distance of 70 feet; this substance was so strongly impregnated with sulphuric acid as to burn the tongue like fire in its intense sourness. All the mud springs are double, and most of the water springs also; each one having, in addition to its crater, and generally in the margin thereof or near it, a honey-comb vent in the ground, or rock, through which sulphur vapor escapes with a frying sound; doubtless a vent for the internal fires below. This rule applies in all localities in the basin. The amount of pure crystaline sulphur deposited in this locality is very great, probably one hundred tons could be gathered in sight on the surface. The continuous supply will one day be turned to account, in the manufacture of acids on a large scale.

There being no water fit to drink in the vicinity, we moved on up the valley, about five miles, through grassy hills and level bottoms, passing several isolated caldrons of gray mud on the way, and camped in a group of them, on the river bank, at the head of the valley. Here trout were caught in abundance, and we fared sumptuously, with the single exception that the river water tasted strongly of chemicals, and that all other available water tasted still worse than the river. Those of the party who sported silver watches now discovered that they were no longer silver, but a greasy, pinchbeck yellow; discolored by the gases in the atmosphere of the spring. Arms were also affected, the polished surfaces becoming spotted with black. Distanc, 12 miles.

Barometer, 22.75; thermometer, 60°; elevation, 7,487 feet.

Twelfth day—September 2.—We remained in camp on the river, and visited springs in the neighborhood. Along the bank of the stream

there are a dozen caldrons of grayish clay mud, varying from 6 to 40 feet in diameter, and from 3 to 10 feet in depth, each with its vent of sulphur vapor and slimy crater, from 3 to 5 feet in height. Just above camp the bed of the river is full of hot-water spouts, with bubbles of gas escaping. In a ravine, over the ridge, hot vapors pour out in every direction, and here is a remarkable group. A small stream of green water flows down the ravine, having its source in a rocky cave in the bank, with an aperture of 6 by 8 feet—a perfect grotto, lined with brilliant metallic tints of green, red, and black, from which steam escapes in regular pulsations to a distance of 40 feet, forcing out the water in waves, which break over an outside horizontal rim, about once in ten seconds. A few yards further down are several boiling springs of yellow muddy-water, the largest of which is 80 feet in diameter, and near it a great honey-comb sulphur vent, 100 feet in diameter, through which the vapor rushes with a loud hissing sound. One hundred yards from the bank of the river, and below these springs, is a geyser of dark muddy water; its basin is 200 feet across on the outer rim, and about 6 feet deep, with a channel cut through one side for the passage of flood water from the hills. The area is floored with a strata of mud rock, deposited from the water, forming a circular plateau, in the middle of which is an oblong crater, 45 by 75 feet, with an irregular vapor vent, and system of steam jets adjoining, covering the whole space to the outer rim on the right. This was a periodic geyser, having eruptions every six hours, and in the following manner: The crater being full of boiling water, and the vapor vent active, suddenly columns of steam shoot up through the water to the height of 300 feet. The ground trembles, the vapor hisses through the vent with increased force. The water of the crater is violently agitated, being thrown up in vast columns, to the height of 30 and 40 feet, splashing out as far as the rim of the basin with great force. This continues for half an hour, the water increasing in quantity in the crater all the while. Then the steam ceases suddenly to escape, the water settles, and commences to lower in the crater, continuing to fall to the depth of 35 feet, leaving bare the incrusted and funnel-shaped walls, which converge at that depth to the diameter of 7 feet. The water here stands for a time, the steam jets cease to hiss, the vapor vent to give forth its fumes, and all is quiet. After the lapse of an hour, the water stoutly rises again, the vents become active, and at the end of the regular period the whole performance is repeated as before.

A few hundred yards from here is an object of the greatest interest. On the slope of a small and steep wooded ravine is the crater of a mud volcano, 30 feet in diameter at the rim, which is elevated a few feet above the surface on the lower side, and bounded by the slope of the hill on the upper, converging, as it deepens, to the diameter of 15 feet at the lowest visible point, about 40 feet down. Heavy volumes of steam escape from this opening, ascending to the height of 300 feet. From far down in the earth came a jarring sound, in regular beats of five seconds, with a concussion that shook the ground at two hundred yards distant. After each concussion came a splash of mud, as if thrown to a great height; sometimes it could be seen from the edge of the crater, but none was entirely ejected while we were there. Occasionally an explosion was heard like the bursting of heavy guns behind an embankment, and causing the earth to tremble for a mile around. These explosions were accompanied by a vast increase of the volumes of steam poured forth from the crater. This volcano has not been long in operation, as young pines, crushed flat to the earth under the rim of mud, were still alive at the tops. The amount of matter ejected was not great, con-

sidering the power of the volcano. The distances to which this mud has been thrown are truly astonishing. Directly above the crater rises a steep bank, a hundred feet in height, on the apex of which the tallest tree near is 110 feet high. The topmost branches of this tree were loaded with mud 200 feet above, and 50 feet latterly away from the crater. The ground and fallen trees near by were splashed at a horizontal distance of 200 feet. The trees below were either broken down, or their branches festooned with dry mud, which appeared in the tops of trees growing on the side hill from the same level with the crater, 50 feet in height, and at a distance of 180 feet from the volcano. The mud, to produce such effects, must have been thrown to a perpendicular elevation of at least 300 feet. As the diameter of the vent is small, in comparison to its depth, it would admit of an initial propulsion, varying little from a vertical line. It was with difficulty we could believe the evidence of our senses, and, only after the most careful measurements, could we realize the immensity of this wonderful phenomenon. In the morning I had forded the river, intending to go down on the other side and examine the steam jets on the Hellroaring River, but the day being warm I was overcome with pain and weakness, and obliged to return without seeing them, to my great disappointment.

Thirteenth day—September 3.—We forded the river opposite camp, and followed up the stream on the east side, passing several of the gray mud caldrons in the first two miles of our course on the river bank. A cañon of small depth here commences, impassable in many places without difficulty, and we bore off to the left on the summit of the wooded ridges. In six miles we struck the river again at a point where it falls over a sloping ridge of lava, in roaring rapids, in a distance of half a mile. The trail is easily passable to the crossing of a creek seven miles from camp, and coming down through a marshy valley from the range on the left. Fording this we were caught in an impassable labyrinth of fallen timber, and obliged to retrace our steps. Recrossing the creek, we followed down its valley, over marshy ground, for two miles, when a broad sheet of water suddenly appeared in front. Crossing the creek once again at a miry ford, skirting an estuary three miles farther along the margin of a heavy forest on the left, then passing over a sand levee, grown up with sage brush, and we found ourselves on the open beach of the great Yellowstone Lake. Camped in a grove on the lake shore. At the head of the creek is a large basin covered with an incrustration of sulphur, and behind the first ridge a number of steam jets were seen rising into the air; these we did not visit. Distance, 12 miles; barometer, lake shore.

Barometer, 22.60; thermometer, 58°; elevation, 7,714$\frac{3}{5}$ feet.

Fourteenth day—September 4.—We did not move camp. The lake lies close to the east range, in the rim of the Great Basin, and presents an appearance at once beautiful and imposing. Its eastern shore extends southward from camp in a line broken by various inlets, to the distance of twenty-six miles. Its general form is triangular, with apices in the south, southwest, and north points, the latter being below our camp three miles, and at the mouth of the creek crossed yesterday. The Yellowstone leaves the lake a mile beyond this angle, and from the west side, starting with a slow current, in a channel one-fourth of a mile wide, and deep enough to swim a horse. The shore on the east side, for five miles, is a broad and level beach of sand, and the lake is shallow for some distance out from the edge. This sand is composed almost entirely of obsidian and those minute crystals known as California diamonds. Near camp, on the edge of the lake, is a small boiling

spring, having numerous spouts far out in the water. At the mouth of the creek are large swampy districts, flooded, and the resort of myriads of water-fowl. The sand of the beach forms a ridge on the shore, cast up by the waters, like those seen on Lake Michigan near Chicago. Farther down the south shore spurs of the range come down into the basin with bluff fronts. On the south side these promontories project far into the lake in great numbers, dividing it into bays and channels. On the west side is a low bluff of the timbered ridges, with a sand beach in front along the margins of the waters. The greatest width of open water in any direction is about eighteen miles. Several islands are seen, one of which is opposite the channel of the river and five miles from the east shore; another is ten miles farther south, and two miles from the shore a mountain isle with a bold bluff all around to the water's edge. These islands doubtless have never been trodden by human footsteps, and still belong to the regions of the unexplored. We built a raft for the purpose of attempting to visit them, but the strong waves of the lake dashed it to pieces in an hour. Numerous steam jets pour out from the bluffs on the shore at different points. The waters of the lake reflect a deep blue color, are clear as crystal, and doubtless of great depth near the center. The extreme elevation of this great body of water, 7,714⅔ feet, is difficult to realize. Place Mount Washington, the pride of New Enuland, with its base at the sea level, at the bottom of the lake, and the clear waters of the latter would roll 2,214 feet above its summit. With the single exception of Lake Titticaeca, Peru, it is the highest great body of water on the globe. No shells of any description are found on the lake shore, nor is there any evidence of the waters ever having stood at a much higher level than the present. Twenty-five feet will cover the whole range of the water-marks. Its annual rise and fall is about two feet. Its waters abound with trout to such an extent that the fish at this season are in poor condition, for want of food. No other fish are seen; no minnows, and no small trout. There are also no clams, crabs, nor turtles—nothing but full-grown trout. These could be caught in mule loads by wading out a few feet in the open waters at any point with a grasshopper bait. Two men could catch them faster than half a dozen could clean and get them ready for the frying pan. Caught in the open lake, their flesh was yellow; but in bays, where the water was strongly impregnated with chemicals, it was blood-red. Many of them were full of long white worms, woven across the interior of the body, and through to the skin on either side. These did not appear to materially affect the condition of the fish, which were apparently as active as the others. I had on the previous evening been nine days and nights without sleep or rest, and was becoming very much reduced. My hand was enormously swelled, and even ice-water ceased to relieve the pain. I could scarcely walk at all, from excessive weakness. The most powerful opiates had ceased to have any effect. A consultation was held, which resulted in having the thumb split open. Mr. Langford performed the operation in a masterly manner, dividing thumb bone and all. An explosion ensued, followed by immediate relief. I slept through the night, all day, and the next night, and felt much better. To Mr. Langford, General Washburn, Mr. Stickney, and the others of the party, I owe a lasting debt for their uniform kindness and attention in the hour of need.

Fifteenth day—September 5.—We moved at 9 a. m. south, along the eastern shore, passing at intervals the extinct craters of several springs crumbling away from the action of the waves. In two miles we came to a low promontory, whence several steam jets arose with a loud roar-

ing sound. Beyond is a small bay, bounded by a deposit of yellow clay, full of concretions, in curious forms of saucers, stockings, pencils, and the like. The bottom of this bay is lined with a whitish sediment which discolors the water along the shore. Hot sulphur springs and lukewarm ponds were abundant. After traveling six miles we were obliged to leave the beach and follow the pine ridges, in many places through fallen timber, with some difficulty. We passed several large alkaline soda springs and numerous swampy hollows between the ridges, camping in a beautiful little valley near the shore of the lake. Distance 15 miles.

Barometer, 22.50; thermometer, 44°; elevation, 7,714$\frac{3}{4}$ feet.

This point affords a fine view of the lake. A strong wind from the west had been blowing all day, and the waves rolled in to the height of four feet. The beach here is of volcanic gravel mixed with calcareous shales, among which we found many beautiful specimens of colored rock crystals and petrefactions. The climate and vegetable growths of the Great Basin are strikingly different from those of the surrounding country. The summer, ~~though short, is quite~~ warm, notwithstanding the elevation of the district. Rains are frequent in the spring months, and the atmosphere is comparatively moist. All the grasses grow rank, and are not of the seeded varieties common to the country, being green and luxuriant, when the lower valleys are parched by the sun. Ferns, huckleberries, thimbleberries, and other products of a damp climate abound, all being of diminutive growth. It is a miniature Oregon in vegetable productions, the pines being about the height of those on the East Virginia shore, and other growths lessened in proportion. Mosquitoes and gnats are said to be numerous in the early summer, but we saw none at all. The snows of winter are very heavy, but the cold is not severe for such an altitude. Doubtless the internal heat and immense amount of hot vapor evolved, exert a powerful agency in moderating the rigor of the climate. The basin would not be a desirable place for winter residence. The only two men I have been able to find who ever wintered there, both came out affected with goitres in the spring. It is a disease very common among the Mountain Crows, many of the old squaws having enormous growths of the tumors, filling the whole space from the chin to the breast.

Sixteenth day—September 6.—We broke camp at 10.30, bearing eastward over the ridges for an hour, then turning south into an open valley, through which runs quite a stream of yellow sulphur-water, heading in the mountain range close by. On the slope of this range, covering an area of three square miles, is the formation known as Brimstone Basin. The whole lower range of the slope for that space is covered with masses of either blue clay or yellow calcareous deposit, perforated by millions of minute orifices, through which sulphur vapor escapes, subliming in masses around the vents. These brimstone basins are numerous, and many of them miles in extent. They are generally found on the lower slopes of mountains, or at the foot of bluffs, but frequently occur in level districts. The latter class are always wet, and generally impassable, the crust of the earth being very thin, with a whitish mass of soft mud beneath—the most dangerous marsh imaginable. Several of our horses were scalded by breaking through in passing over such places.

From this valley our route was greatly obstructed by fallen timber, obliging us to follow the lake shore whenever practicable, and this was often miry, being a bed of soft clay, covered with coarse lava pebbles, growing larger in size as we advanced. In the afternoon we reached

the lower end of the lake, at its southeast angle. Here a large stream comes in through a swampy valley grown up with willows, and about four miles in width. The whole valley is filled with pools of water, a resort for great numbers of water-fowl, but the soil bears up the weight of a horse, though muddy on its surface. The ground was trodden by thousands of elk and sheep. Bear tracks and beaver trails were also numerous, and occasionally was seen the footstep of a California lion. The lake shore was barricaded with stranded pine trees, in huge rafts of driftwood. We endeavored to cross the valley on the beach, but after struggling through the tangled willows for two hours, found the creek channel to be a wide and deep slough, impassable for man or beast. Retracing our steps, we rode along the mountain side up the valley a couple of miles, and camped on its border, at the confluence of a small stream. Distance, 10 miles. During the night we were several times disturbed by the dismal screaming of California lions, and in the morning found their huge tracks close around the camp.

Seventeenth day.—September 7.—In company with Mr. Langford, I climbed to the summit of a neighboring peak, the highest of the east range. We were four hours reaching the highest point, climbing for over a mile over shelly, feldspathic granite, after leaving our horses at the limit of pines.

Summit at noon. barometer, 20.35; thermometer, 65°; elevation, 10,327 feet.

The view from this peak commanded completely the lake, enabling us to sketch a map of its inlets and bearings with considerable accuracy. On the southwestern portion of the lake rose a high mountain of a yellow rock, forming a divide or water-shed in the center of the great basin, beyond which the waters flowed south and west. The stream we failed in crossing on the previous day rises in the southeast range, running east several miles, and joining another stream from the southwest at Bridger's Lake, a sheet of water about two miles in diameter, at the foot of a rocky peak about twenty-five miles to the south, from whence the stream flows due north, in a straight valley, to the Yellowstone Lake. This valley has a uniform width of about three miles, is level and swampy through its whole extent, with numerous lakelets of considerable size scattered at intervals over its surface. South of Bridger's Lake, and beyond the Snake River divide, were seen two vast columns of vapor, thirty miles away, which rose at least 500 feet above the tops of the hills. These were twenty times as large as any we had previously seen, but lay a long distance out of our course, and were not visited. Looking east, one mountain succeeds another, with precipitous ravines, volcanic, rugged, and in many places impassable, as if all the fusible portions of the mountains had melted and run away, leaving a vast cinder behind. There were no ranges of peaks; it was a great level plain of summits, with the softer portions melted out, the elevations all coming up to the same level, and capped with horizontal beds of surface lava. This formation extended to the limit of vision. The deep and narrow valleys were grassed and timbered, had sparkling streams, and furnished basins for numbers of small lakes; in fact, there are lakes here everywhere, on the summits of the mountains and on their terraced slopes, in valleys and in ravines, of all sizes, shapes, and qualities of water.

Descending the mountain we followed the trail of the party, crossing the stream a mile above our camp, where it is 100 feet wide and 3 feet deep, with a moderate current. Thence we followed to the right through a beautiful open forest, across the grassy valley, passing two little gems

of lakes at the foot of high ridges, on the west side. Presently the trail turned up the slope of the mountain, where night overtook us. After traveling some distance I discovered we were following a band of elk, having missed the trail in the darkness. We then struck out for the lake shore, on which our course was regained, but presently lost again after more elk. We then built a fire and examined the ground carefully for tracks, found the right direction, and at 10 o'clock at night arrived in camp on the lake shore, to the relief of our companions, who supposed us lost in the mountains. Our camp to-night is due south from the head of the Yellowstone, on the other side of the lake. Long, wooded promontories here extend out into the basin, inclosing bays several miles in length. These are so numerous as to render it impossible to give a correct profile of the shore without actual measurement, the perspective in such distances rendering appearances very deceiving. Distance, 9 miles.

Eighteenth day—September 8.—We traveled across a high promontory running into the lake, winding among steep ravines and through fallen timber lying in heaps, with full-grown, living forest above it. This timber must have been deadened by fire, the trunks being bare of limbs and much decayed, but in such masses as to be impassable in many places, causing us to make wide detours to find a trail. The standing forest is very dense; the pack animals ran between trees, often wedging themselves in so tightly as to require some trouble in extricating them; several of the packs burst, causing numerous delays. Our faces were scratched, clothes torn, and limbs bruised squeezing through between saplings. After a hard day's work, traveling at all points of the compass for a distance of at least fifteen miles, we struck a stream leading north through a deep ravine and followed it down. Presently the ranges opened out, skirting a pretty little bottom, in which we camped. Distance direct, 7 miles.

Messrs. Hedges and Stickney wandered off from the party in the morning, but struck the shore of the lake and followed it, meeting us shortly after going into camp. In the evening a grizzly bear, with cubs, was roused by some of the party, but as they had not lost any bears she got away with her interesting family undisturbed. These animals are very numerous in the basin, the green grasses, berries, and pine nuts affording them abundant supplies of food; but our party kept up such a racket of yelling and firing as to drive off all game for miles ahead of us. The numbers of springs of water on the slopes of these ridges is surprising, large districts on the hill-sides being swampy and often impassable. The water from the granite rocks is always good; from all others bad. The small lakes are perfectly alive with otter, which may be seen playing upon their surfaces at night-fall by hundreds. Beaver, mink, and muskrat are also abundant.

Nineteenth day—September 9.—We moved in a westerly course over the summit of a high promontory, thence descending into a narrow open valley, and crossing a small stream rising in the promontory between two arms of the lake and flowing south. This creek, rising as it were in the very midst of the Yellowstone Lake, is the source proper of Snake River; five miles below it empties into a stream flowing from a heart-shaped lake five miles in diameter. This stream is about 70 feet wide, 3 feet in depth, and is the main fork of Snake River. This explains the origin of the old story of the "Two Water" Lake, or Spring, to the effect that the two streams, the Yellowstone emptying into the Gulf, and the Snake river into the Pacific, had a common source. The proximity is truly unparalleled, the waters of one stream actually running from be-

tween the waters of the other. Passing thence westward we became entangled in fallen timbers of the worst description on steep hillsides, and among impassable ravines, but finally emerged into an open flat on the promontory, and camped at the fountain-head of the Snake River. Distance, 5 miles.

Barometer, 22.65; thermometer, 45°; elevation, ——.

On going into camp it was discovered that a pack-horse was missing. This animal, a small Cayuse, had been uniformly unfortunate, miring down in marshes, tumbling over log-heaps, and rolling endwise down steep banks; he was found a couple of miles back firmly wedged between two trees. Mr. Everts did not come in with the rest of the party, and men sent back on the trail found no traces of him. We fired signal guns, and kept watch-fires during the night, but without success. Supposing that he had passed to the right or left, we moved on the next day, leaving men behind on the trail.

Twentieth day—September 10.—We broke camp at 10 a. m., taking a westerly course through fallen timber and over steep ridges, striking a long, slender arm of the lake in the afternoon; camped on this inlet—distance, 5 miles. Parties then went back on the trail, and laterally, hunting Mr. Everts. Messrs. Hauser and Langford ascended a high peak near camp and fired the woods, in hope of giving him a point of direction. We also fired signal guns during the night. In the evening large numbers of fish were caught, Private Williamson catching fifty-two large trout, all that two men could carry, in less than an hour. The night passed away and the missing man did not come. In the early morning we were serenaded by a couple of lions, their melancholy voices echoing through the heavy forest with a peculiar, wild, and mournful sound. We had blazed trees at all our camps throughout the whole trip, leaving on each a record, with date, route, and distances marked on the hewn sections. Here we also hung up in sight a few rations, hoping Mr. Everts might strike our trail and follow after we had gone.

Twenty-first day—September 11.—I started in advance, with Messrs. Hauser and Langford, rounding the arm of the lake, at the head of which a narrow valley, with a small stream, comes in; thence striking due west, up a steep ridge, we reached on its summit a plateau of open woods with grassy spaces between, and a perfect net-work of small lakes, their surfaces covered with the broad leaves of the tiger lily. These extended for miles on either side, as the promontory is very extensive, running far out into the waters of the great lake. After an easy ride in a direct line of seven miles, we reached the extreme westerly and longest arm of the lake, a lovely bay of water, six miles across, and with steam jets rising at its southern extremity in great numbers. Opposite the head of this arm is the great yellow mountain seen from Mount Langford several days ago. This is the central point from which radiate double barriers, separating the waters of the Yellowstone from the Snake, and the latter from the Madison, Snake River flowing on the east side of the mountain southerly, and the Firehole branch of the Madison rising in a small lake to the west of the range, the main branch coming from Henry's Lake, south of this. This mountain may be said to be the focus of volcanic action in the basin, the greatest phenomena being observed within a radius of thirty miles from its summit. From its yellow, sulphureted appearance it can be readily distinguished, and is the central and most important landmark in the great basin. We camped on the arm of the great lake three miles north of its extremity, and on the east side. Here we remained in camp during the 12th, 13th, 14th, and 15th, searching constantly for Mr. Everts. During the night

a heavy snow-storm set in, which continued at intervals throughout the next day.

Twenty-second day—September 12.—To-day parties went out in couples on the search. Messrs. Smith and Trumbull followed the lake shore around the head of the promontory to within sight of our previous camp. They returned in the evening and reported having seen human footsteps in the sands of the beach. Mr. Smith was positive he saw several Indians on foot, who retreated into the woods on being approached. They were probably white men, as a man was met in the neighborhood a few days afterward who stated that he belonged to a small party in the vicinity. In the middle of this promontory is one lake of considerable size, and at a high elevation above that of the Yellowstone. Messrs. Washburn and Langford took a southerly direction toward the base of the Yellow Mountain, for a distance of eleven miles. They saw from the divide the lake from which Snake River issues, also a small lake at an elevation of 800 feet above it. Beyond this divide they became entangled in an immense swampy brimstone basin, miles in extent, abounding in sulphur springs, small geysers, and stream jets. The ground was covered with tufa, or calcareous deposits in a thin scale, overlying hot white mud. Mr. Langford's horse broke through several times, coming back plastered with the white substance and badly scalded. They were unable to penetrate to the lake on account of the instability of the footing.

Twenty-third day—September 13.—The snowy weather continued with intervals of hail and rain; large fires were kept up, and the search continued. I rode around the head of the lake to the steam jets visible from camp; this was the largest system we had yet seen, located at the extreme point of the most westerly arm of the lake, and on a gentle slope, reaching along the shore for a mile, and extending back into the woods for the same distance; this system embraced every variety of hot water and mud springs seen thus far on the route, with many others heretofore unseen. Four hundred yards from the lake shore is a basin of mud having a bright pink color; this is a system of itself, being 70 feet in diameter, and projecting thick mud through small craters of a conical shape around the edge of the basin, while the center is one seething mass. The deposit speedily hardens into a firm, laminated clay stone, of beautiful texture, though the brilliant pink color fades to a chalky white. Near and around this basin are a dozen springs, from 6 to 25 feet across, boiling muddy water of paint-like consistency, in colors varying from a pure white to a dark yellow; then come several flowing springs, from 10 to 50 feet in diameter, of clear, hot water, the basins and channels of which were lined with deposits of red, green, yellow, and black, giving them an appearance of gorgeous splendor; these deposits were too friable to preserve, crumbling at the touch. The bright colors were on the surface of the rock only, not extending to its interior. Below these were several large craters of bluish water impregnated with sulphate of copper; these boiled to the height of two feet in the center and flowed large streams of water; their rims were raised a few inches, in a delicate rocky margin of a fringe-like appearance, deposited from the water. Beyond these are two lakes of purple water, hot, but not boiling; these give deposits of great delicacy of coloring. Near by are two more bluestone springs, the largest we have yet seen; one, 30 by 40 feet and of temperature 173°, flows a stream into the other one about 70 feet distant, and six feet lower; this latter spring is 40 by 75 feet, temperature 183°; a stream of 100 inches of water flows from it. The craters of these springs are of calcareous stalagmite, and lined with

a silvery white deposit which illuminates, by reflection, the interior to an immense depth; both craters have perpendicular but irregular walls, and the distance to which objects are visible down in their deep abysses is truly wonderful. No figure of imagination, no description of enchantment, can equal in imagery the vista of these great basins. West of these is a group, of clear, hot water, which surpass them all for singularity, though not in beauty; these are basins of different sizes and unknown depths, in which float what appear to be raw bullock-hides as they look in a tanner's vat, waving sluggishly about with every undulation of the water; the resemblance is complete. On examination the leathery substance proves to be a fragile texture, something like the vegetable scum in stagnant pools, ("and yet it is not vegetable,") with brilliant colors of red, yellow, green, and black, on the shaded side. It is easily torn and could not be preserved, unless indeed by pressure, like rose leaves; it has the thickness and flabbiness of rawhide, and is quite heavy when wet. Digging down into the basins, I found that this singular substance filled the whole depth, layer upon layer being deposited; and, stranger than all, the lower strata were solidified, turning to pure, finely-grained sheets of alabaster, specimens of which I brought in.

On the margin of the lake is a double row of calcareous springs at the boiling point, (here 185°,) which do not flow, except at intervals. These build up craters of solid limestone, from 5 to 20 feet in height; many of these stand in the waters of the lake, and several are partially broken away by the erosive action of its waves. There are two flowing ones, with low craters from 20 to 30 feet in diameter, which run as much as 50 inches of boiling water each. Of these, the walls of the craters are visible to a great depth, inclining at a sharp angle under the bed of the lake, and separated from it by thin barriers of shelving rock. All along the shore, for a mile, runs a terrace of calcareous stalagmite, in a deposit of from 20 to 50 feet in depth, the edges of which are worn to a bluff bank by the action of the waters. This stratum has been deposited by the mingled streams of mineral waters of every sort, which flow from the springs above and flood its whole surface. The rock is stained with variegated colors, which speedily fade, but specimens obtained from the lower beds, and bleached in the lake, are the purest of alabaster. Scattered over the surface of this terrace are masses of calcareous tufa, which, when dried, will float in water. Not less than 1,000 inches of hot water flow into the lake at this point, and numberless jets can be seen boiling up far out in its basin. In this enumeration I have described but a few of the largest springs; there are hundreds of them, including vapor vents, mud spouts, and still caldrons. They are scattered through the woods in such numbers as to require the utmost care to prevent stumbling into them at every turn.

Occasionally this anomaly is seen, of two springs, at different levels, both boiling violently; one pours a large and constant stream into the other, yet the former does not diminish, nor does the latter fill up and overflow. Most of the springs, however, seem to be independent of each other and to come from immense depths, having different levels at the surface, different temperatures, and pulsations; seldom are found the waters and deposits of any two exactly alike. It is impossible to adequately describe, and utterly impossible to realize from any description, more than a faint idea of the beauties and wonders of this group. The fire kindled on the summit of the mountain has by this time spread to a vast conflagration, before the devouring flames of which tall pine trees shrivel up and are consumed like grass. The whole summit of the mountain sends up a vast column of smoke which reaches to the sky, a

pillar of cloud by day and of fire at night. I returned to camp in the evening profoundly impressed with the greatness of the phenomena we were witnessing from day to day, and of their probable future importance to science, in unraveling mysteries hitherto unsolved. Messrs. Hauser and Gillette returned in the evening, unsuccessful in their search. The snow, hail, and rain, by turns, continued, and lions were again heard during the night.

Twenty-fourth day—September 14.—We remained close in camp; the weather continued stormy; the snow was now twenty inches deep, and fell almost constantly; our pavilion tent served us admirably; without it we should have suffered great inconveniences for lack of shelter. The water-fowl of the lake deserve a passing notice. These include swans, pelicans, gulls, Canada geese, brants, and many varieties of ducks and dippers. There are also herons and sand-hill cranes. Of pelicans, immense numbers sail in fleets along the lake, in company with the majestic swan. The gulls are of the same variety as those found in San Francisco Harbor. I think the pelicans are identical with those found in the great lakes on the northern border; but am not sure, as we did not get a specimen. There are several low, flat islands in the lake which are always white with them at the close of the day. Of birds and animals of the forest, I have seen of each several, not down in the books, comprising, of birds, a sort of large mocking-birds, two varieties, belonging, I think, to the genus "corvus;" two kinds of woodpeckers; two or three species of grouse; also a guide-bird, resembling a blackbird, but larger. I saw but one of these—the day I went to the bottom of the Grand Cañon; it hopped and flew along from rock to rock ahead of us during the whole trip down, waited perched upon a rock while we were resting, and led us clear to the summit again in the same manner, making innumerable sounds and gestures constantly, to attract attention. Others of the party remarked birds of the same kind, and acting in the same manner. The common birds of the basin are eagles, hawks, ravens, ospreys, prairie chickens, and grouse. Of animals, I saw several species of squirrels and weasels which do not appear in the books. We saw no snakes of any kind in the basin.

Twenty-fifth day—September 15.—The snow-storm abated, clouds hung overhead in heavy masses, an oppressive dampness pervaded the atmosphere, the snow melted away rapidly under the influence of a warm wind from the west. The only traces of Indians we had seen were some shelters of logs, rotten and tumbling down from age, together with a few poles standing in former summer camps; there were no fresh trails whatever. Appearances indicated that the basin had been almost entirely abandoned by the sons of the forest. A few lodges of Sheep-eaters, a branch remnant of the Snake tribe, wretched beasts who run from the sight of a white man or from any other tribe of Indians, are said to inhabit the fastnesses of the mountains around the lakes, poorly armed and dismounted, obtaining a precarious subsistence, and in a defenseless condition. We saw, however, no recent traces of them. The larger tribes never enter the basin, restrained by superstitious ideas in connection with the thermal springs. A party of three can travel with perfect safety, so far as Indians are concerned, in any part of this district, by keeping close watch upon their horses at night, as the lions would make short work with them if an opportunity was afforded, horse-flesh being their favorite diet.

Twenty-sixth day—September 16.—We moved around the arm of the lake to the hot springs previously described, camping near them; distance, 5 miles.

Barometer, 22.70; thermometer, 44°; elevation, 7,714⅔ feet.

The shore line is bordered by a levee of obsidian, lava pebbles, and calcareous fragments, cutting off and inclosing ponds of water behind it, from which the surplus waters flow out through crevices in the dike. These ponds are the accumulated waters of thousands of springs breaking from the ground all along the line of the beach. The lake bottom is everywhere free from caverns, and gradually sloping to deep water. The ruins of old spring craters appear at intervals along the shore. In the afternoon the snow had diminished to a general depth of six inches, and exposed locations were bare. We spent the evening in collecting specimens from the different springs and laying in a supply of fish for future use.

Twenty-seventh day—September 17.—In the morning we noticed a great commotion among the hot springs. Many heretofore quiescent were now active and flowing. Others, which previously boiled gently, sent up clouds of steam, and threw water to the height of three and four feet. Evidently they have their periods of increased action, like those we saw on the Yellowstone below. Before leaving camp a council was held, which resulted in our leaving Mr. Gillette, with Privates Moore and Williamson, to make a final effort in the search for Mr. Everts. They were provided with one pack mule and ten days' rations. They were to go back to Bozeman by our former route, or at discretion make a search and follow on our trail.

Starting at 9 o'clock in a northwesterly course, we traveled up a gradual declivity through open timber four miles, to the summit of the divide, then descending for about the same distance, we crossed a deep, open valley, containing a headwater tributary of the Firehole branch of the Madison. The course then lay over the summit of a very steep ridge, 1,000 feet in altitude, the face of which was covered with masses of fallen timber, through which we found a passage of the utmost difficulty. Passing the summit, a glimpse was obtained of a good-sized lake, the source of the Firehole. Skirting then a ridge to the northward, over a country very much broken, we soon began to descend, and finally reached the bottom of an open ravine, abounding with springs of good water, where we camped. Distance, 12 miles.

Barometer, 22.65; thermometer, 50°; elevation, 7,535 feet.

Twenty-eighth day—September 18.—We broke camp at 9 o'clock, traveling along the slopes of the ridges, skirting the ravines through falling timber, and passing in many places over swampy terraces, for a distance of three miles, when we suddenly came upon a mountain torrent, 40 feet wide, and running through a gorge of trachyte lava 200 feet in depth. This was the Firehole River, heading in a lake a few miles to the south. Following down the course of this stream we presently passed two fine roaring cascades, where the water tumbled over rocks to the depth of 20 and 50 feet successively. These pretty little falls, if located on an eastern stream, would be celebrated in history and song; here, amid objects so grand as to strain conception and stagger belief, they were passed without a halt.

Shortly after the cañon widened a little, and on descending to a level with the stream we found ourselves once more in the dominions of the Fire King. Scattered along both banks of the infant river were boiling springs, depositing calcareous craters. These varied from 2 to 12 feet across, and were all in active eruption, the cones deposited varying from 3 to 40 feet in height, and sometimes covering a space of one-fourth of an acre. A feature of these craters is, that they gradually seal themselves up and stop the flow of their water, by depositing around the interior

edges a deep fringe of rock, the points of which finally meet across the openings of the craters, forming a sort of sieve, which finally closes entirely, forcing the waters to break out in some other place. Numbers of these self-extinguished craters are seen scattered along both banks of the stream, having now become cones of solid rock. Most of the waters are clear, and the deposits are usually calcareous, but we found a few springs of water resembling ink, from which the deposit was a black hard rock, composed largely of silica, and extremely flinty, shattering the blades of our hatchets, and giving forth showers of sparks when struck by them. The valley here descended rapidly, and we soon saw in front dense columns of steam rising above the hills. After traveling two miles among these springs of various kinds, and through several bogs on the slopes, we came suddenly upon an open rolling valley of irregular shape, about two miles in width and three in length. This valley is known in the wretched nomenclature of this region as the Fire-hole, and contains phenomena of thermal springs unparalleled upon the surface of the globe. Crossing the river we moved down to a central point of the valley, and camped in a little grove of pine timber near the margin of a small marshy lake, around which were to be seen numerous fresh signs of buffalo, driven out by the noise of our hasty intrusion. Distance 6 miles.

Barometer, 22.70; thermometer, 40°; elevation, 6,626 feet.

The valley is of triangular shape, with an obtuse angle on the south side of the river, which runs parallel with its longer side, and about three hundred yards from the foot of the range. At the apex of the obtuse angle a stream 50 feet wide comes in from the south, joining the main river in the midst of the valley, below its central point. The mountain ridges on all sides are 1,500 feet in height, composed of dark lava, in solid ledges, are heavily wooded, and very steep. Small groves of timber also cover the highest points of the valley, which is a succession of ridges, and of rounded knolls capped by springs, the intervening depressions being rendered marshy by the overflow of their waters. The whole surface of the basin, to an unknown depth, is a calcareous bed, deposited from the springs. Near the head of the valley, immediately after crossing to the south side of the river, we came to one of the geysers, which was at the time throwing water, with a loud hissing sound, to the height of 125 feet. In a few minutes the eruption ceased, and we were enabled to approach the crater. This had originally been a crack or fissure in the calcareous ledge, the seam of which could be traced by minute vents a distance of 60 feet, but was now closed up by deposits from the water to an opening 7 feet long by 3 feet wide in the center, from which the steam escaped with a loud, rushing sound. The hillock formed by the spring is 40 feet in height, and its base covers about four acres. Near the crater, and as far as its irruptive waters reach, the character of the deposit is very peculiar. Close around the opening are built up walls, 8 feet in height, of spherical nodules, from 6 inches to 3 feet in diameter. These, in turn, are covered on the surface with minute globules of calcareous stalagmite, incrusted with a thin glazing of silica. The rock, at a distance, appears the color of ashes of roses, but near at hand shows a metallic gray, with pink and yellow margins of the utmost delicacy. Being constantly wet, the colors are brilliant beyond description. Sloping gently from this rim of the crater, in every direction, the rocks are full of cavities, in successive terraces, forming little pools, with margins of silica the color of silver, the cavities being of irregular shape, constantly full of hot water, and precipitating delicate coral-like beads of a bright saffron. These cavities are also fringed with rock around the edges, in

meshes as delicate as the finest lace. Diminutive yellow columns rise from their depths, capped with small tablets of rock, and resembling flowers growing in the water. Some of them are filled with oval pebbles of a brilliant white color, and others with a yellow frost-work which builds up gradually in solid stalagmites. Receding still further from the crater, the cavities become gradually larger, and the water cooler, causing changes in the brilliant colorings, and also in the formations of the deposits. These become calcareous spar, of a white or slate color, and occasionally variegated. The water of the geyser is colorless, tasteless, and without odor. The deposits are apparently as delicate as the down on the butterfly's wing, both in texture and coloring, yet are firm and solid beneath the tread. Those who have seen stage representations of "Aladdin's Cave," and the "Home of the Dragon Fly," as produced in a first-class theater, can form an idea of the wonderful coloring, but not of the intricate frost-work, of this fairy-like, yet solid mound of rock, growing up amid clouds of steam and showers of boiling water. One instinctively touches the hot ledges with his hands, and sounds with a stick the depths of the cavities in the slope, in utter doubt in the evidence of his own eyes. The beauty of the scene takes away one's breath. It is overpowering, transcending the visions of the Moslem's Paradise. The earth affords not its equal. It is the most lovely inanimate object in existence. The period of this geyser is fifty minutes. First an increased rush of steam comes forth, followed instantly by a rising jet of water, which attains, by increased impulsions, to the height of 125 feet, escaping with a wild, hissing sound, while great volumes of steam rise up to an altitude of 500 feet from the crater. Rainbows play around the tremendous fountain, the waters of which fall about the basin in showers of brilliants, then rush steaming down the slopes to the river. After a continuous action for a space of five minutes, the jet lowers convulsively by degrees, the waters finally disappear, and only a current of steam pours forth from the crater. When we consider that it plays through an aperture 7 by 3 feet in measurement, an idea can be formed of the vast quantity of water ejected by this great natural fountain. In the neighborhood of this are several old geysers, choked up by their own deposits to small, simmering craters, with their outside slopes decomposed and shelly.

Following the edge of the valley southward, we passed hot springs of various sizes, from 2 to 50 feet in diameter, with craters built up in rounded knolls, from 3 to 40 feet above the general level. All these were of clear water, without sulphur vents; most of them had periodical turns of violence, during which they threw off immense columns of steam and water in jets from the center of their basins to heights varying from 3 to 50 feet. Many of these springs gave evidence of having been once geysers of the first class, but their waters in such cases had burst out from excess of pressure in large springs at the bases of the old craters, where they were building up anew. Large swampy places in the hollows were formed of a greasy, calcareous slime, covered with turf, growing evergreen from the warm water below. In many localities there were large groups of standing trees in these marshes, dead and denuded of bark to the height of three feet, their bare trunks being of a snowy whiteness and fast turning to stone. These were always found in places where hot water flowed down at some period from geysers above. They presented, with their deadened tops and bare and whitewashed stumps, a very singular appearance. No sulphur springs, nor sulphur deposits, are found in the valley; but few mud springs are seen, and these are small in dimensions. Along the margin of the

stream, coming in from the south, are swampy flats, from which many partially submerged craters project. These boil violently and flow quantities of hot water, but do not throw jets. Near the mouth of the stream, and on the west side, is a lake of bluestone water, 100 feet in diameter, with steam evolving from its waters, which flow over a low rim in every direction down the slopes, depositing a yellow bed, which is now many feet in thickness. Below this, on the margin of the stream, is a spring 30 feet in diameter, boiling with great fury, and flowing a large stream into the creek. On the opposite side, at a distance of fifty yards, a fissure in the strata becomes visible, six feet in width and of unknown depth. It is bridged in most places with rock, but has frequent steam vents, and runs a large stream of hot water from west to east with a rapid current. This stream can be traced for a distance of three hundred yards, the rush of its subterranean waters being distinctly audible from under ground. In the angle of the woods at the mouth of the creek are several large bluestone springs, some flowing, others quiescent. Whole trees fallen in the craters of these are incrusted with a white, calcareous deposit, and gradually turn to stone; leaves, pine cones, grasshoppers, and twigs, are also thus incrusted in the most delicate manner. In these springs are calcareous deposits in the shape of mushrooms, with tops spreading out at the surface of the water. These are often fifteen feet in diameter, and supported by stems ten feet high and two feet thick, all of solid rock. There are two cones on the opposite bank, 40 to 50 feet in height, with small springs in their summits. The space in the angle between the streams is partially filled with a slimy marsh. Along both banks of the Firehole River are the greatest of the geysers. Our camp was a few hundred yards below the first crater described, and the most beautiful of them all. Near the bank of the river, and a half a mile below camp, rose on the farther margin of a marshy lake the Castle Crater, the largest formation in the valley. The calcareous knoll on which it stands is 40 feet in height, and covers several acres. The crater is built up from its center, with irregular walls of spherical nodules, in forms of wondrous beauty, to a castellated turret, 40 feet in height and 200 feet in circumference at the base. The outer rim, at its summit, is formed in embrasures between large nodules of rock, of the tint of ashes of roses, and in the center is a crater three feet in diameter, bordered and lined with a frost-work of saffron. From a distance it strongly resembles an old feudal tower partially in ruins. This great crater is continually pouring forth steam, the condensation of which keeps the outside walls constantly wet and dripping. The deposit is silver-gray in color, and the structure is wonderful in its massiveness, completion, and exquisite tracery of outline. At the base of the turret lies a large pine log, covered with a nodular and brilliant incrustation to the depth of several inches. The wood of this log is also petrified. The waters of this geyser have burst out in a new place, near the foot of the old crater, flowing a large stream, boiling violently, and diminishing the action of the great vent, yet we saw the latter on one occasion throw water to the perpendicular height of 60 feet, with the escape of heavy volumes of steam. It had doubtless been, when intact, the greatest fountain of them all. Near by, and on the same hillock, is a bluestone spring, with an indented marginal basin, 25 feet in diameter; this stands level-full. Its interior lining is of a silver tint, and the water in its perpendicular shaft appears to be of unfathomable depth.

A few hundred yards farther down the stream is a crater of flinty rock, in shape resembling a huge shattered horn, broken off half way

from its base. It is 12 feet in height, with a solid base; its sides have a curvelinear slope, ragged edges, and its cavity or nozzle is 7 feet in diameter. During its quiescent state the boiling water can be seen in its chambers at a depth of 40 feet, the action of the steam and water together producing a loud rumbling sound. Near and acting in concert with it are half a dozen smaller craters from 2 to 8 feet in height constantly full of water, and boiling violently from 2 to 6 feet into the air. This great geyser played several times while we were in the valley, on one occasion throwing constantly for over three hours a stream of water 7 feet in diameter from 90 to 200 feet perpendicularly. While playing it doubled the size of the Firehole River, running at its maximum about 2,500 inches of water. Two hundred yards below this is a grotto formation, similar in structure to the turreted spring; this is 20 feet in altitude, 40 feet in outside diameter, and has side apertures large enough for a man to crawl into; these lead to cavernous craters on the interior. A large and singular pillar of stone stands in the middle of the vent. Several of the party crawled through the interior when it was quiet, but an hour afterward it was throwing a column of water 6 feet in diameter to the height of 60 feet. Near it were several large vents in which water boiled to the height of 6 feet constantly, and large streams of water ran from these down the banks into the river. Still farther below, and on the opposite bank of the stream, are two small craters, with apertures two feet each in diameter; these two are connected, one throwing steam, and the other water, and also alternating with another small crater below. First the stream would rush from the upper crater, roaring violently, then this would suddenly cease, to be followed by a fan-like jet of water rising from the lower crater to the height of over 40 feet, often playing for perhaps two minutes; then this would suddenly stop flowing, and the steam would rush forth again for a time. Occasionally the small crater threw a transverse stream, sometimes alternating with either of the others; and thus they played on for hours, after which all would subside to a gentle bubbling. All along both banks of the river are small craters and spouts built up in every conceivable shape; all were active except the geysers, and each entirely independent of the others. Several streams of water poured out in cascades from round holes in the rocky bank of the river, and a number of little geysers played from 6 to 40 feet at intervals.

Opposite camp, on the other side of the river, is a high ledge of stalagmite, sloping from the base of the mountain down to the river; numerous small knolls are scattered over its surface. The craters of boiling springs from 15 to 25 feet in diameter; some of these throw water the height of 3 and 4 feet. In the summit of this bank of rock is the grand geyser of the world, a well in the strata 20 by 25 feet in diametric measurements, the perceptible elevation of the rim being but a few inches, and when quiet having a visible depth of 100 feet. The edge of the basin is bounded by a heavy fringe of rock, and stalagmite in solid layers is deposited by the overflowing waters. When an eruption is about to occur the basin gradually fills with boiling water to within a few feet of the surface, then suddenly, with heavy concussions, immense clouds of steam rise to the height of 500 feet. The whole great body of water, 20 by 25 feet, ascends in one gigantic column to the height of 90 feet, and from its apex 5 great jets shoot up, radiating slightly from each other, to the unparalleled altitude of 250 feet from the ground. The earth trembles under the descending deluge from this vast fountain, a thousand hissing sounds are heard in the air; rainbows encircle the sumits of the jets with a halo of celestial glory. The fall-

ing water plows up and bears away the shelly strata, a seething flood pours down the slope and into the river. It is the grandest, the most majestic, and most terrible fountain in the world. After playing thus for twenty minutes it gradually subsides, the water lowering into the crater out of sight, the steam ceases to escape and all is quiet. This grand geyser played three times in the afternoon, but appears to be irregular in its periods, as we did not see it in eruption again while in the valley. Its waters are of a deep ultramarine color, clear and beautiful. The waving to and fro of the gigantic fountain, when its jets are at their highest, and in a bright sunlight, affords a spectacle of wonder of which any description can give but a feeble idea. Our whole party were wild with enthusiasm; many declared it was 300 feet in height; but I have kept, in the figures as set down above, within the limits of absolute certainty. We were led to believe by indications on the rocks that some of these geysers do occasionally play to an altitude of 500 feet, but this we did not see. Above, on the slope of the mountain, is another great geyser which has lately broken out. It has deadened the timber on a wide space, and for half a mile between its crater and the river. It must run a perfect torrent of water at its periods of eruption.

I have now described seven of the largest geysers seen in the Firehole Basin, and the description falls far short of the reality. To do justice to the subject would require a volume. The geysers of Iceland sink to insignificance beside them; they are above the reach of comparison. We could not distinguish, on every occasion, the geysers from the other hot springs, except by seeing them play, and doubtless there are many besides in the valley of great size, which we saw when quiet, and classed as boiling springs. They all vary in times, force, deposits, and colors of water. The number of springs of all kinds in the valley is not less than fifteen hundred; and, with the exception of the Bluestone Springs, scarcely any two are exactly alike. Taken as an aggregate, the Firehole Basin surpasses all other great wonders of the continent. It produces an effect on the mind of the beholder utterly staggering and overpowering. During the night we were several times awakened by the rush of steam and the hissing of the waters, as the restless geysers spouted forth in the darkness. A constant rumbling, as of machinery in labor, filled the air, which was damp and warm throughout the night.

Twenty-ninth day.—This morning we were awakened by a fearful, hissing sound, accompanied by the rush of falling water, and, looking out, saw on the other side of the stream a small crater, three feet in height, and with an opening of 26 inches diameter, which had scarcely been noticed on the previous day, and was now playing a perpendicular jet to the height of 219 feet, with great clouds of steam escaping, and causing the ground to tremble as the heavy body of water fell with tremendous splashes upon the shelly strata below. Huge masses of the rocks were torn from their places and borne away into the river channel. It played thus, steadily, for ten minutes, giving us time to obtain an accurate measurement by triangulation, which resulted as above stated. This crater gave no notice of being a geyser; its appearance and size were altogether insignificant, compared with others. We were more than ever convinced that continued observation would develop the knowledge of geysers in greater numbers, and perhaps of greater projectile force than any we had seen. Our rations were becoming scarce, however, and seven days had been comparatively lost in searching for Mr. Everts. We sent the train in advance at 9 o'clock, and waited all the forenoon at the grand geyser, in hopes of witnessing another eruption. The waters rose gradually until the great crater was nearly filled, but

did not play, and we were forced to leave without witnessing a repetition of the phenomena.

Moving down the stream on the north side, past springs and small geysers of every variety, for a distance of three miles, we then traversed a valley five miles in length, swampy in many places, and in others much obstructed by fallen timber. Thermal springs were scattered along the whole route, but none large enough to be remarkable here. In eight miles we came to an enormous bluestone spring, nearly circular in form, 450 yards in circumference, and of unfathomable depth, boiling hot, and with clouds of steam evolving from its surface. It has built up a hill 50 feet above the general level, and covering about 100 acres with a calcareous bed. The margin of the great basin is bounded by a rim 30 feet back from the brink of the crater, and elevated a few inches. The waters overflow in every direction, keeping the long slopes constantly wet. The deposits are of variegated colors—a circumstance not before remarked in any springs of this class; the water boils up slightly in many places far out in the basin, but steadily, and with no indication of violent or periodic action. The steam rising is evolved from the surface of the water, and does not escape through it from beneath. The margin of this lake is a hundred and fifty yards from the river, which has cut away its deposit to a bluff bank, 46 feet in height, at that distance. Between this bluff and the basin, but at a lower level, by 20 feet, is a geyser with a basin 50 feet in diameter, and playing a strong jet from the center to the height of 20 feet. Just beyond this, and at a different level still, are several smaller geysers, and a bluestone spring 70 feet in diameter. Flowing from these latter over the bank into the river are five streams of boiling water, either one large enough to run an ordinary grist mill. These steaming cataracts are among the most beautiful we have witnessed on the trip. Below the Great Basin, and at a distance from the bank, are two more bluestone springs, respectively 75 and 100 feet in diameter. These do not flow. Here the valley opens out to several miles in width, being of triangular shape, and about twelve miles in length. The Madison River comes in from the south, along the west side of this valley, joining the Firehole River at its northwest angle. In this large valley has formerly been a repetition of Firehole Basin, but on a much larger scale. On the south side are two hills of calcareous deposit, having gigantic but extinct craters on their summits. These hills are for the most part bare on the slopes, but are in some places grown up with pine timber, and are 800 feet in height. Some of the fragments of the crater walls are 50 feet in altitude. The south side, between the forks of the rivers, contains innumerable extinct craters of great size, and a few small ones, in operation, but with a low grade of action. On the north side of the Firehole River the valley slopes gradually from the bluffs to the river, a space of three miles in width, and is a calcareous swamp, with the summits of extinct craters projecting by hundreds above its surface. This great marsh has been deposited by waters from a vast series of geysers and springs along the foot-hill range; though much decreased in action many of these are still in operation, and for miles the swamp is yet flooded with their waters. These we passed at a distance, and without visiting, but saw their clear fountains and stream jets playing on the side hill, as we threaded the swamp. The amount of water flowing down from this system is enormous, and it was with the utmost difficulty that we found a passage through the slimy morass. Along the banks of the Firehole River were seen numerous stream jets, and in the center of the valley is

quite a range of hills, now grown up with timber, but which were formerly craters of immense geysers. Around their bases are ponds of tepid water, and the deposit of the great marsh rises high up on their slopes. Near the lower end of the valley a large stream comes into the Firehole from the north, just above its junction with the Madison. This stream runs through a deep and beautiful valley in the range, and judging from the color and deposits from its waters, has large systems of thermal springs somewhere on the line of its course. The Madison comes in a mile below, in a stream fifty yards wide, and two feet deep, a mountain torrent, running on a bed of solid lava, and having its source in Henry Lake, about forty miles above. The whole valley has a singularly ruinous and melancholy aspect. The few groups still in activity, and the thousands of extinct and broken craters, attest the grandeur of its former phenomena. An air of desolation settles upon the landscape which renders it almost painful to contemplate.

Following down the river bank through a deep cañon of volcanic rocks, in many places broken in huge fragments, we presently came to rapids, having a fall of perhaps 40 feet in a half mile. At this point the channel narrows to 150 feet, and is shut in by perpendicular rocks. We were obliged to scale the ridge above, and follow down the stream on its summit, through dense timber and steep ravines, with considerable difficulty. In three miles we reached a level bottom, on the river, at the junction of a large creek coming in from the northeast. Camped at the junction. Distance 18 miles.

Barometer, 23.50; thermometer, 43°; elevation, 6,594 feet.

Thirtieth day—September 20.—We now thought ourselves clear of the geysers, but in the morning were surprised to see a graceful column of steam ascending to the height of 300 feet on the opposite side of the creek and in the elbow of a mountain range. We did not visit this group, but forded the Madison twice just below camp, and followed down its right bank. The river is here shut in by a cañon of high lava mountains rising with a perpendicular front of from 1,000 to 2,000 feet. The bare rocks stand out in impassable walls seamed with fissures and scarred by storms of centuries. Huge fragments in many places overhang the narrow path. In others the summits of the wall are composed of trachyte, overlaid with masses of basaltic columns of immense height.

Often the grassy, narrow shelf on the margin of the stream is covered with débris, and we were frequently obliged to take to the river, which runs on a ledge of lava full of deep cavities and strewn with large boulders. After threading our way thus for twelve miles through the grandest vistas of volcanic mountain scenery, the ranges suddenly fell away to the right and left, and we entered upon a great plateau, heavily timbered, and sloping to the west. This was the upper valley of the Madison, and is within the limits of the Great Basin. We passed rapidly down this uniform slope for ten miles, all the way through timber, in many places deadened by fire, coming in on the river bank in the center of the valley, and thence followed down to an open district, in the middle of which rise two hills of considerable altitude. Mr. Langford and myself ascended to the summit of the highest of these and obtained a full view of the surrounding country. The valley is nearly circular, about twenty miles in diameter, with the Madison running from south to north through its center. The land slopes gradually to the river from east and west. Two large streams head in the east and west points, skirting the margin of the valley through rolling prairie lands, and joining the Madison near the north point. The land is open all around the edges of the valley, but its central

portions are heavily timbered, a circumstance very unusual in this country. The timber is wholly pine, the valley being above the region of cottonwood. The river bottom is much lower than the slopes, which terminate in bluffs on both sides of the stream. The formation is débris washed down from the mountains, and covered by a deep loamy soil. In the narrow bottom are numerous small lakes swarming with water-fowl. The river channel is extremely crooked and full of islands, and the woods abound with game of various sorts. The great Bannack trail crosses the valley from west to east, from the Snake River to the head-waters of the Gallatin. We should have skirted the foot-hills on the east side, and thus have avoided the timber, but were traveling by the compass and could not see the lay of the country on account of the dense forest. We camped three miles north of the two hills, near the junction of one of the streams, and eight miles from the head of the cañon through which the river flows out of the valley. Distance, 27 miles.

Barometer, 23.50; thermometer, 38°; elevation, 6,434 feet.

This district has a bad reputation, as being a place of rendezvous for the bands of horse-thieves and road agents which infest the Territory; its dense forests, moderate climate, enormous range, and abundance of game rendering it a pleasant and secure retreat for lawless men.

Thirty-first day—September 21.—We moved at 9.30 a. m. down the river, traveling for eight miles through a constantly narrowing arm of the valley, thickly grown up with sage brush. We then entered a cañon extending for ten miles, very crooked, with a general trend to the north-west, and breaking through a high volcanic range, heavily timbered in places. The trail was easy, and the bottom of the cañon quite hilly, heavy masses of débris having fallen from the lava summits on either side. The walls of the cañon are steep but seldom perpendicular, and numerous ravines, the channels of small streams, come in laterally. Numbers of large springs gush out, high up on the mountain sides, forming cascades which tumble down the rocks, glittering in the sunlight like ribbons of silver. This range forms a section of the outer rim of the Great Basin, and its summits are above the altitude of the drift. The river channel falls rapidly throughout the whole length of the cañon, and debouches at its outlet into the middle valley of the Madison, where we came once more into Montana scenery — a broad valley of bare sloping ridges, flat on their summits, and composed of modified drift, with sparsely timbered mountains beyond, to the limit of vision. The river here turns sharply to the north.

Following the slope to the great range on the right, we traveled over foot-hills of drift. Numerous streams come down from the range through deep ravines worn in the slopes. The summits of the peaks are Russia granite, and some of the lower ones are ground smooth by the drift-current. The ground descends with great rapidity, and in ten miles we came to a series of bluffs, falling away northward into another and much lower terrace of the valley. The lateral streams from the range now became larger, and ran over beds of cobbles and boulders of every variety of granite, the feldspathic and Russian being most frequently found. Surface lava cropped out on the hill-slopes, but the whole lower valley is one mass of modified drift. We camped in a deep wooded ravine by the side of a clear mountain torrent, sheltered completely from a cold wind storm which had chilled us all the afternoon. Distance, 26 miles.

Barometer, 23.60; thermometer, 32°; elevation, 6,382 feet.

The night was clear and cold. Ice froze to the depth of one and one-half inches on still water, by morning.

Thirty-second day—September 22.—We started at 8 o'clock, climbing the steep slopes of the ravine, and following the table lands for several miles. The valley widened constantly, and the huge granite peaks grew higher and higher as we descended to a lower level. After following the slopes for six miles we went down to the river bank, and there found numerous prospect holes in the drift and wagon tracks, showing a near approach to settlements. In twenty-four miles the valley again fell off in steep bluffs of drift cobblestones, and we came to a lower terrace on which occasional herds of stock were seen grazing. Cottonwood timber now appeared in the place of the pines, the valley widened to twelve miles, the bottom or lowest terrace along the river being a bed of washed granite boulders lightly covered with earth for the most part, but in places bare rocks for the space of hundreds of acres. The stream ran bank-full, over a bed of the same formation. The lava no longer appeared in the valley, though huge masses cropped out from the lateral ranges. The granite peaks here tower above on the right to the height of over 3,000 feet, their bald summits glistening in the sunlight reflected from the red granite and the masses of snow. We camped on the river bank in sight of the upper settlements of the Madison. Distance, 38 miles; altitude, 4,937 feet.

Thirty-third day—September 23.—We moved down the river, crossing two miles below camp at a point nine miles distant from Virginia City, and striking the road to Sterling, which follows the valley for ten miles. The river then bends to the northeast through a deep gorge in the hills which bound the valley on the north. The level portions of this valley are well settled with numerous large farms near the head of the cañon and along the borders of a district overflowed at some seasons of the year. All crops are here irrigated; and small grains produce abundantly. At the point where the road leaves the valley for Sterling I separated from the Helena party—taking a near cut over the hilly range to the Madison bridge, at the crossing of the Virginia City and Gallatin Valley road. This road passes over ridges burrowed in every direction after quartz, and through ravines with arastras and quartz mills on their streams. I halted for the night at the bridge on the Madison. Distance, 35 miles.

Barometer, 25.00; thermometer, 38°; elevation, —— feet.

In the cañon of the Lower Madison are found large numbers of small petrefactions of great beauty. These are brought down by the current from the volcanic regions above, and are highly prized for settings of jewelry.

Thirty-fourth day—September 24.—I started for Fort Ellis at 9 a. m. The road is passable for stages, and leads over rolling hills eastward to the Gallatin Valley, which is about sixteen miles across from east to west, and thirty miles in length. The west or main branch of the Gallatin River, rising in the north rim of the great Yellowstone Basin, flows northward through this valley. Its bottom lands are grown up with cottonwood, and its waters afford irrigation to fertile farms, which already support a population of over two thousand. This valley is regarded as the finest settled portion of Montana. It is superior in all natural resources to many of the most valuable districts east, and resembles in many respects the Cumberland Valley, in Pennsylvania, with the exception that nature works on a grander scale in the wilds of the West than elsewhere. The mountains are higher, the scenery is more picturesque, and the air and waters clearer than any found east of

the Missouri. The formation of the Gallatin Valley is of modified drift, in terraces falling successively to the lowest point. Wood and grasses are abundant, and stock maintain themselves at large, in good condition, without being fed at all during the winter. I arrived at Fort Ellis in the afternoon; distance 35½ miles. Privates Moore and Williamson returned on the 2d of October. They had gone back on the trail to our second camp, on the south side of the lake; thence struck the head of Snake River and followed down the stream for a distance of twenty-five miles from the Yellowstone Lake. They found game plentiful and tame, and had no difficulty in obtaining an abundant supply. After an ineffectual search of five days they followed our trail, arriving without accident at the above date. Mr. Everts was found on the 10th of October by two men from the Yellowstone agency. On the first day of his absence he had left his horse standing unfastened, with all his arms and equipments strapped upon his saddle; the animal became frightened, ran away into the woods, and he was left without even a pocket-knife as a means of defense. Being very near-sighted, and totally unused to traveling in a wild country without guides, he became completely bewildered. He wandered down to the Snake River Lake, where he remained twelve days, sleeping near the hot springs to keep from freezing at night, and climbing to the summits each day in the endeavor to trace out his proper course. Here he subsisted upon thistle-roots, boiled in the springs, and was kept up a tree the greater part of one night by a California lion. After gathering and cooking a supply of thistle-roots he managed to strike the southwest point of the lake, and followed around the north side to the Yellowstone, finally reaching our camp opposite the Grand Cañon. He was twelve days out before he thought to kindle a fire by using the lenses of his field-glass, but afterward carried a burning brand with him in all his wanderings. Herds of game passed by him during the night, on many occasions when he was on the verge of starvation. In addition to a tolerable supply of thistle-roots, he had nothing for over thirty days but a handful of minnows and a couple of snow-birds. Twice he went five days without food, and three days without water, in that country which is a network of streams and springs. He was found on the verge of the great plateau, above the mouth of Gardiner's River. A heavy snow-storm had extinguished his fire; his supply of thistle-roots was exhausted; he was partially deranged, and perishing with cold. A large lion was killed near him, on the trail, which he said had followed him at a short distance for several days previously. It was a miraculous escape, considering the utter helplessness of the man, lost in a forest wilderness, and with the storms of winter at hand.

Thus the Yellowstone Expedition closed. We saw many strange and wonderful phenomena, many things which would require volumes for adequate description, and which in future geography will be classed among the wonders of the earth; yet we only followed up the Yellowstone River, passed around two sides of the lake, and down one branch of the Madison to the main stream. We did not explore one-third of the Great Basin. The district will be in easy reach of travel if the Union Pacific Railroad comes by way of the lower Yellowstone Valley. The difficulties of the journey amount to but little after the various routes had been laid down correctly. From the 1st of June to the 1st of October the climate is very mild, considering the location. As a country for sight-seers, it is without parallel; as a field for scientific research, it promises great results; in the branches of geology, mineralogy, botany,

zoölogy, and ornithology it is probably the greatest laboratory that nature furnishes on the surface of the globe.

In one special and important particular a thorough survey of this region would be of use. It is the apex of the greatest water-shed in the northwest Territories, and such a survey would locate correctly the sources of a large number of streams, including the Missouri, Yellowstone, Big Horn, and Snake Rivers. The existing maps are all far from correct in the bearings of all these rivers near their sources, the Upper Missouri being located several miles west of its true position, and too much space being left between the heads of all these great streams, thereby shortening all their channels. By correctly locating their sources, the labor of tracing their channels would be greatly simplified, as the successive trends of the streams could then be worked up from either of two known points—the head or the mouth.

Accompanying this report are appended a table of meteorological observations taken at different points along the route, a geological profile of the country traversed, and a general map of the country. This latter has been compiled from our observations, together with those of a surveyor who went around by the north side of the lake last year. It connects on the west side with lines of territorial survey, as a base, and is believed to be as correct as a map of so large a district can be made in the absence of actual measurements of the ground traversed.

Very respectfully, your obedient servant,

G. C. DOANE,
Second Lieutenant Second Cavalry.

First Lieut. JAMES E. BATCHELDER,
First Lieutenant Second Cavalry, Post Adjutant.

METEOROLOGICAL OBSERVATIONS OF THE YELLOWSTONE EXPEDITION.

Date.	Station.	Aneroid barometer.	Thermometer.	Altitude.*	Remarks.
1870.			°	*Feet.*	*Worked by Burt's tables.*
Aug. 22	Fort Ellis, Montana Ter†.	25.20	62	.....	Morning.
Aug. 22	.....do.....	25.25	92	4,911	Noon; mean of 2 observ'ns; altitude.
Aug. 22	Bozeman Divide.....	24.10	70	6,140	Noon.
Aug. 23	Trail Camp.....	24.30	54	5,803	Morning.
Aug. 23	Butler's Ranch.....	25.10	40	4,837	Evening, stormy weather.
Aug. 24	.....do.....	25.10	40	4,837	Morning, stormy weather.
Aug. 25	Yellowstone Cañon.....	25.10	40	4,837	Morning.
Aug. 25	Gardiner's River.....	24.80	77	5,383	Evening.
Aug. 26	.....do.....	24.60	49	5,215	Morning.
Aug. 26	Crossing Divide.....	23.10	72	7,331	Noon.
Aug. 27	Antelope Creek.....	23.80	57	6,367	Morning.
Aug. 27	Hot Spring Creek.....	23.60	60	.....	Evening.
Aug. 28	.....do.....	23.70	46	.....	Morning.
Aug. 29	.....do.....	23.70	45	6,546	Morning; mean of 3 obs'ns; altitude.
Aug. 29	High Mountain South.....	21.60	65	9,113	Noon.
Aug. 29	Washburn's Peak.....	20.80	50	9,966	Do.
Aug. 30	Camp Jordan.....	23.00	50	7,270	Morning.
Aug. 31	Near Falls.....	22.60	46	.....	Do.
Aug. 31	.....do.....	22.70	58	.....	Evening.
Sept. 1	.....do.....	22.50	32	7,607	Morning; mean of 3 obs'ns; altitude.
Sept. 1	Mud Springs.....	22.75	60	.....	Evening.
Sept. 2	.....do.....	22.60	32	.....	Morning.
Sept. 3	.....do.....	22.60	32	7,487	Morning; mean of 3 obs'ns; altitude.
Sept. 4	Yellowstone Lake.....	22.60	58	.....	Morning.
Sept. 5	.....do.....	22.50	44	.....	Do.
Sept. 6	.....do.....	22.40	38	.....	Do.
Sept. 7	.....do.....	22.50	32	.....	Do.
Sept. 7	Langford's Peak.....	20.35	65	10,327	Noon.
Sept. 7	Yellowstone Lake.....	22.50	32	.....	Morning.
Sept. 8	.....do.....	22.60	45	.....	Do.
Sept. 9	.....do.....	22.50	44	.....	Do.
Sept. 10	.....do.....	22.60	55	.....	Do.
Sept. 11	.....do.....	22.60	55	.....	Do.
Sept. 12	.....do.....	22.40	40	.....	Morning, rainy and snowing.
Sept. 13	.....do.....	22.50	36	.....	Morning, snowing hard.
Sept. 14	.....do.....	22.60	44	.....	Morning, rainy.
Sept. 15	.....do.....	22.70	44	.....	Morning.
Sept. 16	.....do.....	22.65	50	7,714 3-5	Morning.‡
Sept. 17	.....do.....	22.70	40	7,535	Morning, rainy.
Sept. 18	Snow Camp.....	23.50	43	6,626	Morning, clear.
Sept. 19	Firehole Basin.....	23.50	38	6,594	Morning.
Sept. 20	Madison River.....	23.60	32	6,434	Do.
Sept. 21	Madison Cañon.....	23.70	40	6,382	Do.
Sept. 22	Madison River.....	25.00	38	4,937	Do.
Sept. 23	Madison Settlements.....	.....	.....	.....	No observations.
Sept. 24	Madison Bridge.....	.....	.....	.....	

* Altitudes calculated from an ocean-level barometer, 30 inches; thermometer, 60°.
† Fort Ellis, Montana Territory, latitude, 45° 45′; longitude, 110° 53′ west.
‡ Rainy. Mean of 15 observations. Altitude.

These altitudes all fall short, as the Aneroid barometer does not indicate with accuracy above 5,000 feet.

G. C. DOANE,
Second Lieutenant Second Cavalry.

HEADQUARTERS DEPARTMENT OF DAKOTA,
St. Paul, Minnesota, February 8, 1871.

Respectfully forwarded to the Adjutant General of the Army, with the following remarks:

On the 14th day of August, 1870, Mr. H. D. Washburn, surveyor general of Montana, requested an escort for a party desiring to determine by exploration the location of the lake and falls of the Yellowstone. I directed that the escort be furnished, and that an officer be sent with it who could make a report of the trip, as well as a map of the country passed over. Second Lieutenant G. C. Doane, Second Cavalry, was the

officer detailed, and his report is herewith inclosed. The map will be forwarded as soon as received.

There is much information contained in this report, and I deem it worthy of publication.

There is a record of observations accompanying the report which might well be furnished to some scientific corps or institution, even if the report be not published.

WINF. S. HANCOCK,
Major General United States Army, Commanding.

HEADQUARTERS OF THE ARMY,
Washington, D. C., February 16, 1871.

Respectfully submitted to the Secretary of War, with recommendation that this report be printed. It contains much that would interest those who are studying the resources of our new Territories.

W. T. SHERMAN, *General.*